JULY, 1953

APPLIED HYDRAULICS

ENDIX
MISSILE SECTION
LIBRARY

THE MAGAZINE OF FLUID POWER TRANSMISSION

INCLUDING AIR CONTROLS AND AIR CIRCUIT DESIGN; ELECTRICAL CONTROLS

TEMPERATURE MEASUREMENT 47

SERVO CONTROL EQUALIZES BENDING ACTION 53

SANDWICH MANIFOLDS SIMPLIFY PIPING 57

HYDRAULIC POWER ON HEAVY VEHICLES 62

SERVO VALVE DESIGN FOR AUTOPILOT USE 74

Compliments of Tec Engineering Corp.

(SEE OUR ADVERTISEMENT ON THE BACK COVER)

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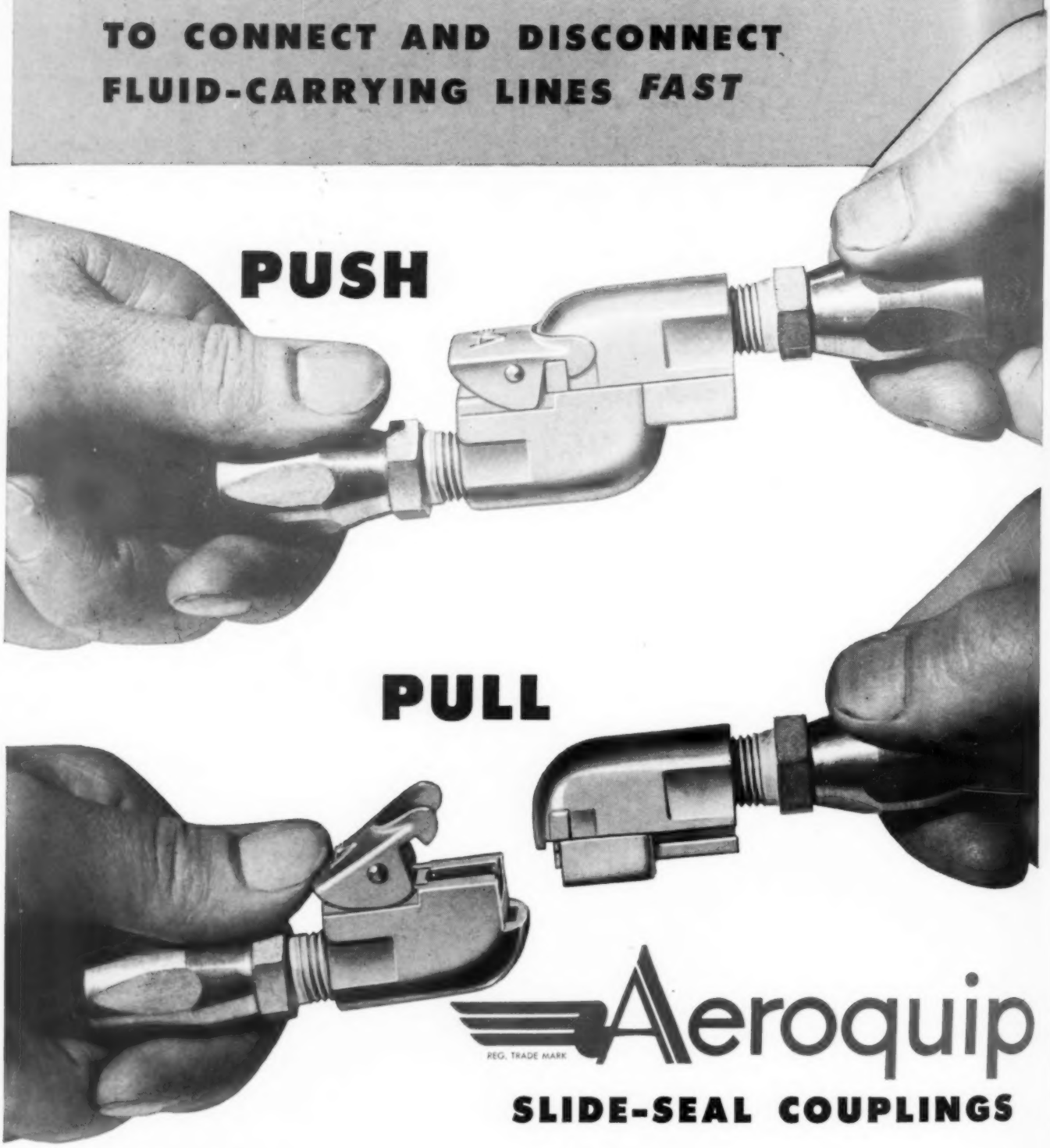

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LOW COST . . . Aeroquip Slide-Seal Couplings connect and disconnect fluid-carrying lines instantly assuring full flow of fluids when connected, and perfect seal of each half when disconnected.

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...how can I use HANNA® cylinder power in my machine tools and equipment?

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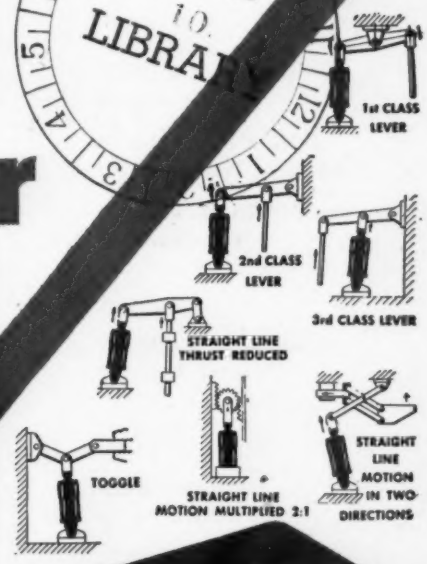

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IF YOU HAVE a push, pull, lift, press, clamp or control problem, Hanna Cylinder Power can be the answer. The mechanical movements here illustrated may suggest ways Hanna Cylinders can be used to simplify the actuation and control of machines or equipment and to replace or reduce manual effort.

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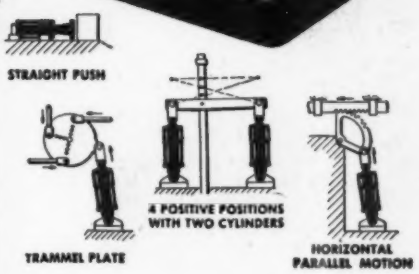

SEND FOR FREE BULLETIN 255

"Cylinder Power in Action" is described in new Bulletin 255. *Write for it today.*

Hanna Engineering Works

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HYDRAULIC AND PNEUMATIC EQUIPMENT . . . CYLINDERS . . . VALVES . . . RIVETERS

JULY, 1953
Vol. 6, No. 7

APPLIED HYDRAULICS

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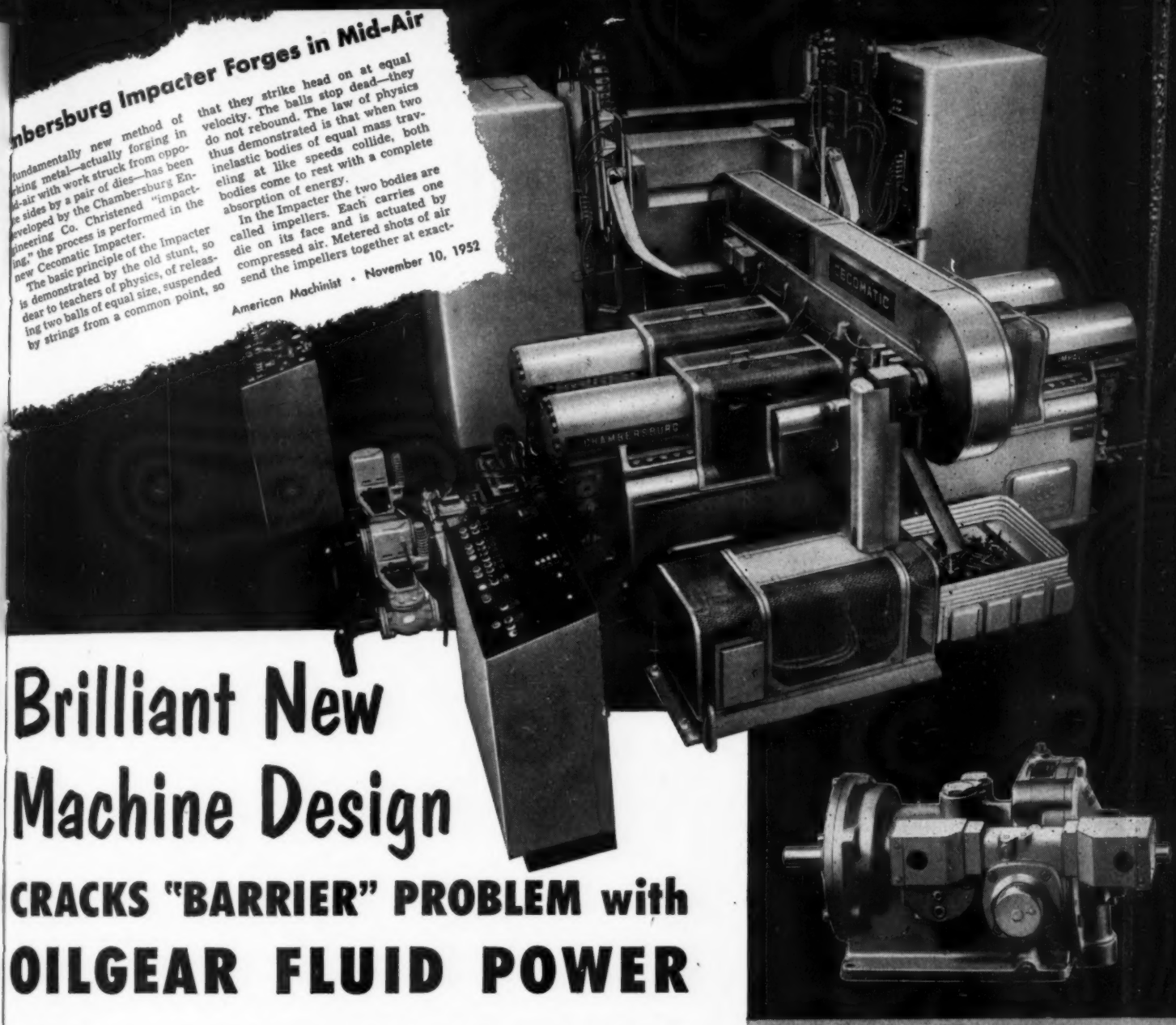
mbersburg Impacter Forges in Mid-Air
fundamentally new method of
rking metal—actually forging in
d-air with work struck from oppo-
te sides by a pair of dies—has been
eveloped by the Chambersburg En-
gineering Co. Christened "impact-
ing," the process is performed in the
new Cecomatic Impacter.
The basic principle of the Impacter
is demonstrated by the old stunt, so
dear to teachers of physics, of releas-
ing two balls of equal size, suspended
by strings from a common point, so
that they strike head on at equal
velocity. The balls stop dead—they
do not rebound. The law of physics
thus demonstrated is that when two
inelastic bodies of equal mass trav-
eling at like speeds collide, both
bodies come to rest with a complete
absorption of energy.
In the Impacter the two bodies are
called impellers. Each carries one
die on its face and is actuated by
compressed air. Metered shots of air
send the impellers together at exact-
American Machinist • November 10, 1952
CECOMATIC
CHAMBERSBURG

Brilliant New Machine Design

CRACKS "BARRIER" PROBLEM with OILGEAR FLUID POWER

Once the "forge-it-in-mid-air" idea occurred to the Chambersburg Engineering people, there were two "barrier" problems to be smashed before the idea became a brilliant reality. Something of the seriousness of the problems is indicated by the fact they spent 10 years to get the right, precise integration of movements and forces required.

One problem, that of getting the blanks to be forged into the right place at the right time for the mid-air forging blow, was eventually solved by recourse to *Any*-Speed Oilgear Fluid Power. The standard totally enclosed Oilgear Transmission with integral electro-hydraulic control gave the designers of the Cecomatic Impacter remote, interlocked, precise control of the conveyor . . . quick, cushioned acceleration . . . high traverse speed . . . fast, cushioned deceleration . . . smooth stop and dwell in forging position; all at the speed and accuracy they needed . . . just as so often in the past Oilgear has given *other* machine designers what *they* wanted.

Maybe your problem can be solved, your machine's performance improved by the smooth, swift acceleration and deceleration of the *Any*-Speed Oilgear. Maybe you need its extreme precision of controllability . . . or any of a dozen other remarkable characteristics. In addition you get simplicity, ease of assembly into your machine, ruggedness, dependability, accessibility, a unique freedom from maintenance.

But whatever your need, *you have not exhausted all possibilities in machine design if you have not investigated Oilgear Fluid Power Pumps, Motors and Transmissions exhaustively.* You too may have a world beater in your hands. THE OILGEAR COMPANY, 1564 W. Pierce St., Milwaukee 4, Wis.

Cecomatic Impacter doubles, triples, quadruples—octuples forging production! No jar or vibration. Less metal stress and die wear. Blanks load into conveyor automatically. And automatically the Oilgear type AXB-33 Variable Speed Transmission accelerates conveyor swiftly, smoothly, it smoothly stops with forging blank "dead on target," waits for the forging blow, then accelerates forged part away and new blank into position. Oilgear is adjustable up to 40 cycles per minute, is easily set to any required index distance which is then maintained under complete automatic control with unvarying precision.

OILGEAR

OILGEAR

Fluid Power Lines

Fewer Pipes

We always have a greater than usual happy outlook after we've talked to a man who has worked out a good design idea through all stages of frustration until it provides him with a going business. We get this feeling of growth when we talk with Richard Moese of Almo Tool Company. Mr. Moese, in an article in this issue, describes the application of brazed manifolds to hydraulic systems. His manifolds have proved practical. But during the years he was perfecting the brazing technique for large manifolds, he was one of the best suppliers to Detroit's scrap dealers.

Feed Circuits

How does a pressure compensated flow control valve function? Where should a meter-in, meter out or bleed-off circuit be used? These questions are often asked by machine designers who are first considering oil circuits to feed cutting tools and work tables. You'll find the answers in this month's Data Sheets.

We've been asked one other question by designers who turn to a catalog and find three different valve models for meter-in, meter-out and bleed off valves. They've found that the valves are often interchangeable in spite of the name plate. How come? The answer involves patent law rather than design. There are patents and royalty rights on the application of meter-out valves to certain standard machine tools.

Shop Ideas

Applying hydraulics and pneumatics to shop tooling always involves ingenuity. Because one of our first jobs in industry was designing jigs and fixtures, we have a healthy respect for the ingenuity of tool and die makers. With their help some of our poorer designs were made to look good and often some of the best ideas originated in the tool room.

In a short article by E. W. Friedl a simple, hydro-pneumatic die clamp for a 50 ton press is described. Fundamental principles of hydraulics coupled with clever mechanical ideas went into this design.

Training Programs

One of the special features of our October issue this year will be a check list of hydraulic and pneumatic training programs. We plan to divide these into three groups: (1) training programs in industry; (2) extension or co-operative school courses in hydraulics or pneumatics and; (3) the departments of engineering and technical schools that offer such courses. Some of these courses may be offered for the first time, e.g., Illinois Tech will offer a new course this fall, "Introduction to Oil Hydraulic Power". If you know of such training programs, please send announcements, outlines, dates and other data to the Editor, APPLIED HYDRAULICS.

Prize Papers

A total of 51 papers were submitted in the Prize Paper Contest. These are now being read and scored by the judges. Judges of the papers are Walter Ernst, The Commonwealth Engineering Company of Ohio; J. R. Hemeon, Ternstedt Division of General Motors Corporation; Dean M. Cleaveland, Bendix Products Division of Bendix Aviation Corporation. Winners will be advised about July 10. Announcement of winners will be made in the September issue. The Grand Prize winning paper will be published in the October issue.

Servo Valves

With hydraulic servo controls being applied to so many different aircraft and industrial machines, we feel that the two servo articles in this issue are of great value to equipment designers and users.

The first article tells how a simple servo system is applied to synchronize the travel of bending cylinders on a beam bender. It's a practical application of a control system which automatically senses and compensates for an error.

In the second article, Bell Aircraft's Martin P. Wolpin presents an analysis of design considerations for servo valves. His analysis for spool diameter, stroke, overlap, flow edges, and clearances will assist the engineer who is adding to his knowledge of servo valve design as well as designers who are presently engaged in the application of servo systems.

Martin P. Wolpin

Precision Dyna-seal plays vital role in leak-proof operation of this Hydraulic Relief Valve

Synthetic rubber sealing member bonded to steel ring for sealing circular flat surfaces — no grooves necessary!

Rivett Lathe & Grinder, Inc., uses a *Precision Dyna-seal* in order to simplify the construction of this Balanced Piston Hydraulic Relief Valve. Simple to install and maintain, the valve must give long, leak-free service. The *Precision Dyna-seal* plays a vital part in the valve's efficient operation at 1500 P.S.I.

Everyone is finding *Precision Dyna-seals* the simple answer to many sealing problems. *No grooves*—all you need is a flat surface to seal under bolt heads, rivet heads, cap nuts, flanges, special fittings, etc. Suitable for service with petroleum products, water, many other fluids and gases. *Precision* engineers will help you — and proper deliveries will keep your production lines going. Please send us your inquiries now.

***FREE**—Write for your personal copy of our Dyna-seal engineering data booklet.*

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Flow Rate of Industrial Hose

If available, we would appreciate receiving data in regard to flow rate of various sizes of automotive and industrial flexible hoses. We believe you may have a chart or other literature showing the rate of flow per foot, various oil temperatures desired in order to receive certain flows, surface conditions, etc.

H. P. MERRITT,
Exola Products, Inc.
Los Angeles, Calif.

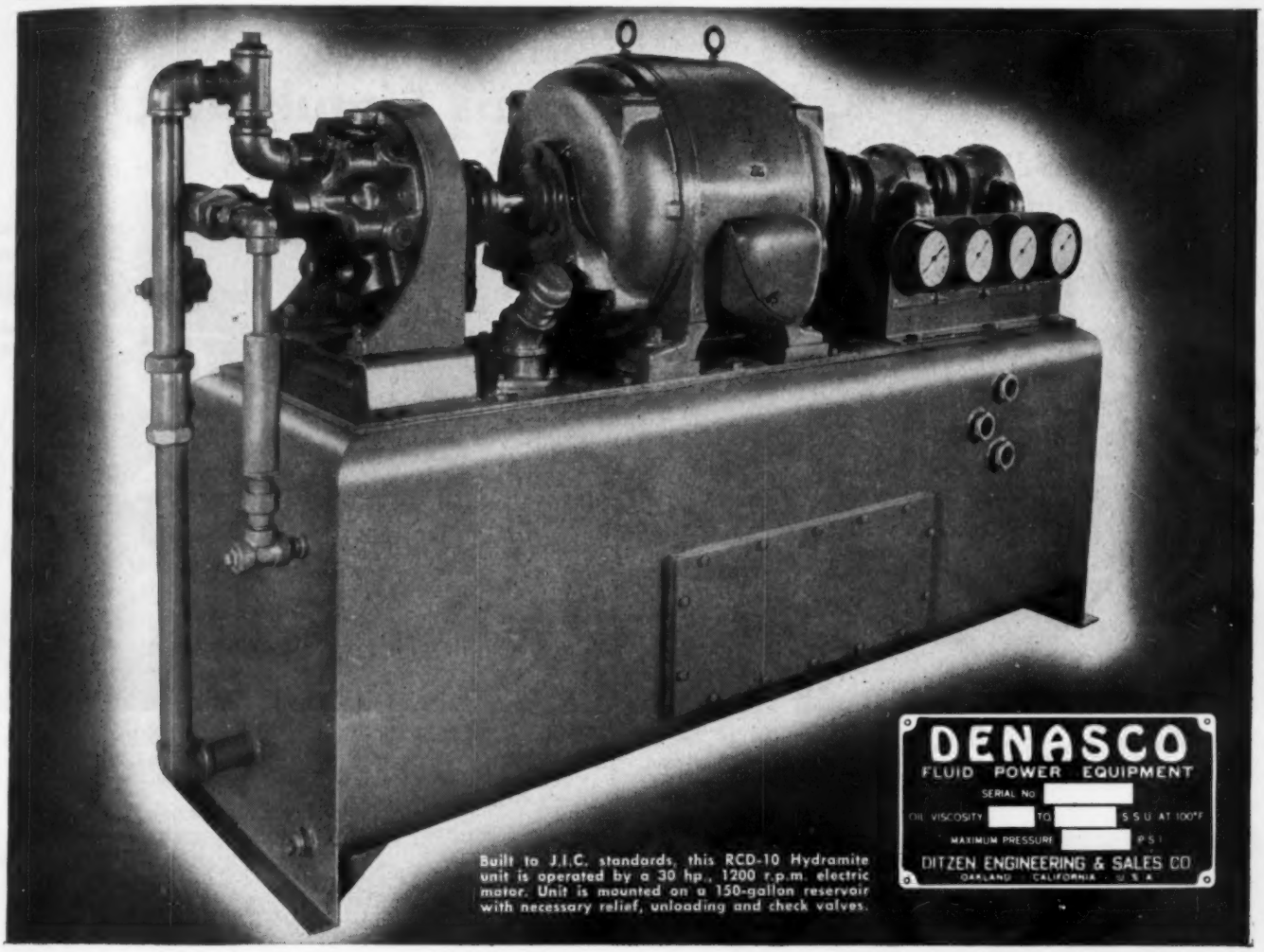
The flow rate is easily computed by formula or by the use of a nomogram. These can be found in handbooks or in literature of manufacturers of such hose. For example, both the formula and the nomogram are found on page 7 of Catalog 49-S, published by Anchor Coupling Co., Inc. Variables such as oil temperatures or surface conditions would, as far as we know, have to be determined by test.

To Tilt Clapper Box on Planer

We should like to apply oil hydraulics for tool lifting on the return stroke of our planing machines. We note (Advertisement of Turchan Follower Machine Co. on page 57 of your March issue) that the clapper box appears to be tilted by means of a hydraulic cylinder and ram fitted into the tool box. We have designed a similar system consisting of a small electric motor driven oil pump giving a pressure of 100 psi in conjunction with a one gallon oil reservoir. The ram piston has an area of one square inch and a stroke of ½ inch. On the initiation of the return stroke a solenoid valve operates and the flow is directed to the rams. At the end of the stroke, the flow is directed back to the reservoir and the clapper box retracts the ram by gravity in swinging back to its normal position. As we have had

Continued on page 9

WHEN IT'S HIGH PRESSURE IT'S AMERICAN!



Built to J.I.C. standards, this RCD-10 Hydramite unit is operated by a 30 hp., 1200 r.p.m. electric motor. Unit is mounted on a 150-gallon reservoir with necessary relief, unloading and check valves.

Here's how your AE representative can help you

WHEREVER YOU ARE LOCATED, your nearby American Engineering hydraulic equipment representative can often save you time and expense in the engineering and construction of high pressure hydraulic pumping systems. An example of this important service is the unit pictured above... designed and built by Ditzen Engineering and Sales Co., the AE representative in Oakland, Calif.

This particular high and low pressure system employs an AE Hydramite. This radial multi-piston, constant displacement, oil-hydraulic pressure generator can maintain pressures to 5000 p.s.i. It is direct-driven through a flexible coupling and rotates in either direction. Hydramite can be flange, foot or face mounted. It maintains its own suction... has overall efficiency of 85%.

Call on your American Engineering hydraulic equipment representative for analysis of any special hydraulic needs, engineering and construction of required systems, and local responsibility for continuous, efficient service. And mail the coupon below for full information about the Hydramite for constant displacement to 10 g.p.m. or the Hele-Shaw for variable displacement to 110 g.p.m.

AMERICAN ENGINEERING
COMPANY
PHILADELPHIA 25, PENNA.

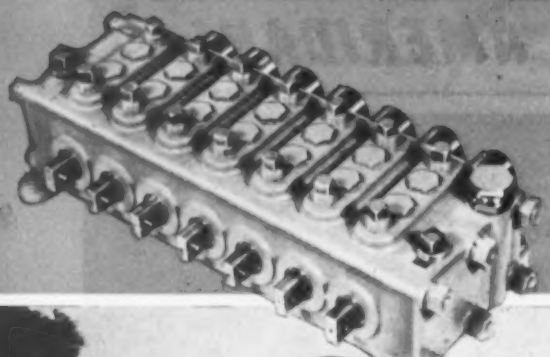
In Canada: Affiliated Engineering Corporations, Ltd., Montreal 2, P.Q.

AE Products are: Taylor and Perfect Spread Stokers, Marine Deck Auxiliaries, Hele-Shaw and Hydramite Fluid Power, Lo-Hed Hoists, Lo-Hed Car Pullers.

American Engineering Company
2530 Aramingo Avenue, Philadelphia 25, Pa.

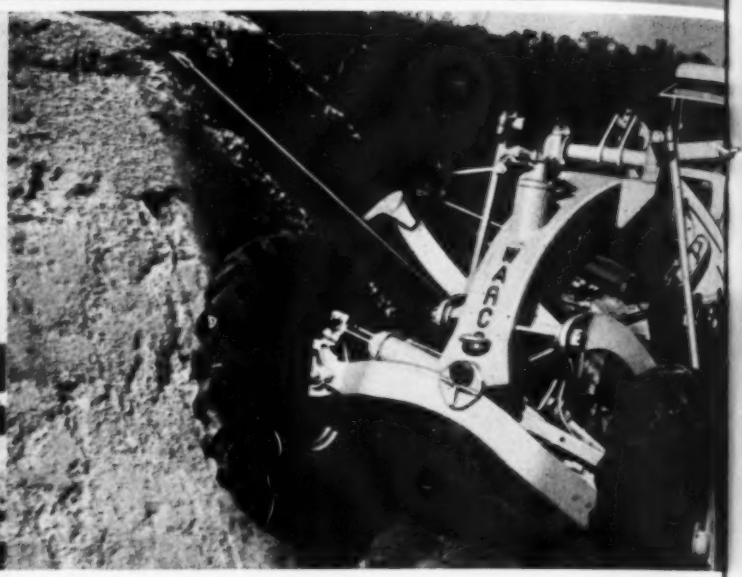
Gentlemen: Kindly send me complete information about the
☐ Hydramite. ☐ Hele-Shaw Pump.

Name.....Title.....
Company.....
Address.....
City.....Zone.....State.....



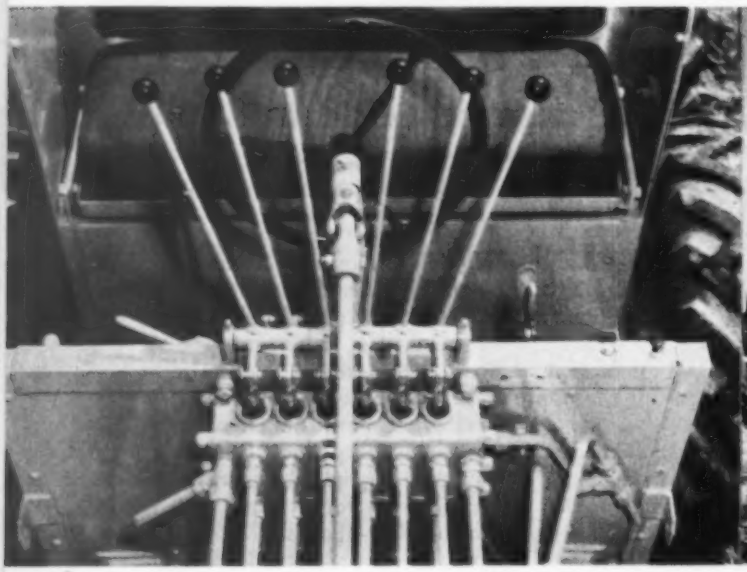
New Sundstrand Multiple Section Series Valve

Controls Two or More Operations Simultaneously



Lifts, shifts blade SIMULTANEOUSLY! Sundstrand Valve permits complete cab control of blade on Warco Motor Grader—a full 180° cross shift of blade carriage from side to side—tilting, raising, or lowering of blade—two or more operations at ONE time!

Wheel lean from right to left, or back again is achieved with fingertip controls in the cab. The same Sundstrand Multiple Section Series Valve permits cab control of the scarifier—lifting or lowering at will of the operator.



Not only is shift of blade carriage controlled from cab, but the operator can lift or lower one or both ends of the blade and rotate the blade, handling two or more operations simultaneously, without loss of time.

Sensitive fingertip control is absolutely essential when laying hot mix to assure a smooth, even surface. Instantaneous response of blade is assured when controlled with a Sundstrand Multiple Section Series Valve. Get bulletin 3104, on this new Sundstrand development.

SUNDSTRAND

SUNDSTRAND HYDRAULICS

SUNDSTRAND MACHINE TOOL CO.

HYDRAULIC DIVISION, ROCKFORD, ILL.

AIRCRAFT AND INDUSTRIAL HYDRAULIC TRANSMISSIONS, PUMPS, MOTORS AND VALVES • OIL BURNER PUMPS • AIR SANDERS
LATHES, MILLING, BROACHING AND SPECIAL MACHINES • BROACHING TOOLS • MAGNETIC CHUCKS

Letters to the Editor

Continued

no previous experience of this application, we are concerned as to whether there would be any appreciable delay in both pushing the clapper box out and on its return to the normal position. In the past we have always used solenoids mounted on the front of our tool boxes and tilted the clapper box by a lever arrangement. We find, however, that it is unsuitable to build these solenoids integral with the tool box, in the same position as we wish to fit the hydraulic rams, owing to their dimensions.

J. STRACHAN,
Scottish Machine Tool Corporation Ltd.
Glasgow, C2, Scotland

The application shown in the Turchan ad uses hydraulic equipment for contour following. This is much more complex than the application which you have in mind for raising the clapper box on the return stroke of the tool. We do not know of any planing machine that uses the device which you suggest. However, we believe your application is sound and see no reason why it should not work. It should be possible to arrange this circuit so that the operation is rapid enough and that there will be no delay in both pushing the clapper box out and on its return to the normal position.

Spiral Back-Up Rings

We have noted two ads in your January 1953 issue (pages 224 and 240) on Teflon Back-Up rings for "O" seals. Can you give us the names of any firms that could give us information on the use of such spiral back-up rings?

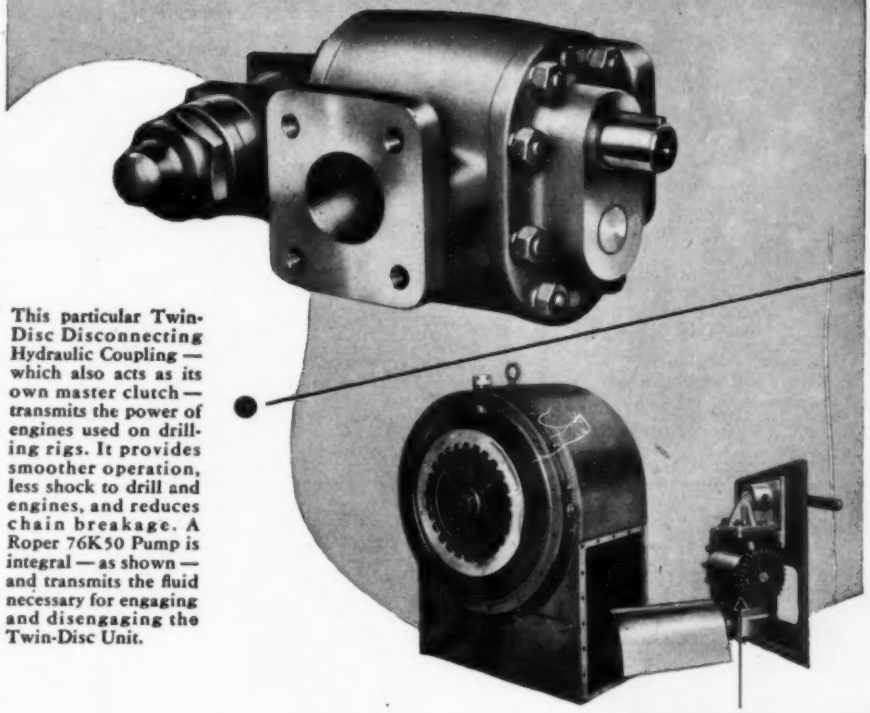
JAMES A. BURBANK,
National Extrusions, Inc.
Arlington, Va.

Mr. Jack Dodge of Reid Enterprises or Herman E. Krebs of Resistoflex Corporation, whose ads you refer to, could give you such application information. Charles Hobson of U.S. Gasket Co., 608 N. 10th St., Camden, N.J. could also give you such information. The Teflon back-up rings are now in wide use in the

Continued on page 14

ROPER

works with Twin-Disc to improve efficiency of this HYDRAULIC POWER TAKE-OFF

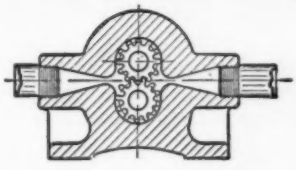


This particular Twin-Disc Disconnecting Hydraulic Coupling — which also acts as its own master clutch — transmits the power of engines used on drilling rigs. It provides smoother operation, less shock to drill and engines, and reduces chain breakage. A Roper 76K50 Pump is integral — as shown — and transmits the fluid necessary for engaging and disengaging the Twin-Disc Unit.

ROPER 76K50 PUMP

YOU CAN EXPECT DEPENDABILITY FROM ROPER

The Roper used as a vital component of this hydraulic power take-off is a special design Series K pump with built-in relief valve. In its role here, the Roper is highly regarded for its great dependability and peak efficiency under rugged conditions. Here's food for thought for you, for you might well have new equipment in process where a Roper would fill the bill. Standard Series K pumps are rated to 150 P.S.I., and delivery ranges of from 3/4 to 50 G.P.M. They are widely used for pressure lubrication, hydraulic service, transfer work, and fuel supply. Series K features (too numerous to mention here) are available to you in our latest catalog. Send for it!



VENTURI SUCTION and DISCHARGE PRINCIPLE IN SERIES K PUMPS

In Series K pumps 10 through 50. A design application whereby liquid is distributed uniformly across the gear face, increasing volumetric efficiency. Adds quietness . . . minimizes energy loss caused by turbulence, cavitation and friction.

GEO. D. ROPER CORPORATION
707 Blackhawk Park Ave., Rockford, Ill.

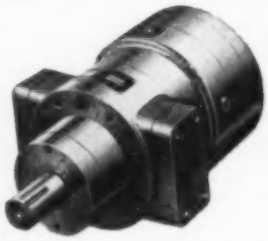
ROPER Rotary Pumps

BUILT TO TAKE IT

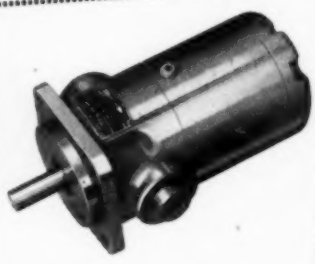
longer, with less maintenance, at pressures up to 5000 psi

SURGE-DAMPING CONTROLS
Industrial and Aircraft Types
Eliminate Destructive Hydraulic Pressure Shock
¼" to 1" Sizes
For Pressures to 5000 psi
Catalog VS-1-A

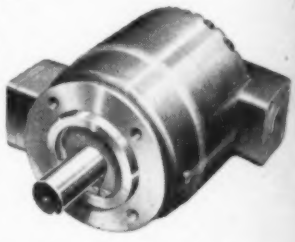
Direct-Operating PRESSURE CONTROLS
½" to 1½" Sizes
For Pressures to 2000 psi
Catalogs VRD-1 through VRD-8



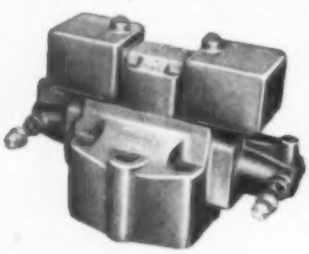
High-Pressure Axial-Piston PUMPS
Constant or Variable Volume
For 2500, 3000 and 5000 psi Circuit Needs
3.5 to 35 gpm Capacities
Catalogs P-4 through P-4-10



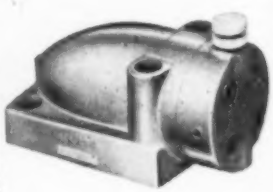
High-Torque Axial Piston FLUID MOTORS
Torque Ratings 13.8 to 112 inch-pounds per 100 psi (about 3 to 180 hp maximum)
For Pressures to 5000 psi
1500 to 3000 rpm
Catalogs FM-1, FM-2, FM-3-A



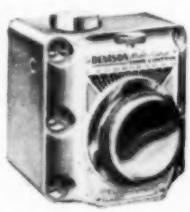
Dual-Purpose, Vane-Type PUMP/MOTOR
Ready for either pump or motor use without change
Shaft rotation in either direction
Four Sizes, 11 Models
Pumping Capacities: 3 to 82 gpm.
Motor Torque: 13 to 257 inch-pounds per 100 psi. Pressures to 2000 psi.
Bulletin P-5



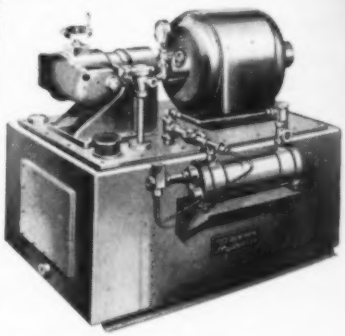
DIRECTIONAL CONTROLS
Manual, Mechanical, Electric or Pilot Control. ¼" to 2" Sizes
For Pressures to 5000 psi
Catalog VD-3



PRESSURE REDUCING VALVES
¾" to 1½" Sizes
20 gpm to 65 gpm Capacities
For Pressures to 5000 psi
Catalog VPR-1



Multi-Range FLOW CONTROLS
Full-Scale Regulation—Adjustable for Varying Input
¼" to ¾" Sizes
For Pressures to 3000 psi
Catalogs VFC-1, VFC-2



PUMPING UNITS
Constant and Variable Volume
46 Models—2 to 35 gpm Capacities
For Pressures to 5000 psi
Bulletins PU-3-A, PU-4 and PU-5

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Proved in use—under many of Industry's toughest operating conditions—Denison HydrOILic Pumps, Motors and Controls are noted for their combination of high efficiency and rugged dependability.

In addition to fine performance under continuous, heavy-duty use, Denison HydrOILic Equipment offers space-saving design that simplifies circuit layout, makes installation easier, and minimizes maintenance problems.

Because so many users verify the extra value built into Denison Pumps, Motors and Controls, we continue the challenge made so often before—*let comparison prove to you* why they are first choice for so many needs of every type. Write today for full details on Denison HydrOILic Equipment to meet your requirements.

Pilot-Operated, Solenoid-Controlled DIRECTIONAL VALVES
Eliminate Spool-Sticking
¾" to 1½" Sizes, For Pressures to 5000 psi
Catalogs VD-1-1 to VD-4-2

Hydraulically Balanced PRESSURE CONTROLS
¾" to 2" Sizes
For Pressures to 5000 psi
Catalogs VR-2-B and VR-5-2

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THE BIG 400-ton hydraulic press shown above is used to stamp out parts for farm machinery in a big midwest plant.

When the press was first put into operation, plant operators followed the recommendation of a Standard Oil lubrication specialist and used STANOIL Industrial Oil in the hydraulic system. In over four years of continuous hard service, there has been no lost time because of inefficient performance of the hydraulic oil.

Oil capacity of the system is approximately 9 barrels; only 2 barrels make-up per year has been required. The oil in this system has never been changed. It has been centrifuged once to remove moisture which accumulated over three years' operation. Periodic tests of oil samples have shown that STANOIL Industrial Oil has maintained its high lubricating quality. A recent analysis showed no increase in viscosity of the oil, no change in color, and a neutralization number of only 0.13 mg. KOH/gm.

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You can rely on this unique many-purpose oil to give you the same clean, dependable service. Get the expert help of a Standard Oil lubrication specialist by phoning your local Standard Oil office.

Or write: Standard Oil Company, 910 South Michigan Avenue, Chicago 80, Illinois.

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You'll find the means to significant savings in this booklet. It describes the important qualities of STANOIL Industrial Oil and the resultant benefits which have made this multi-purpose oil the choice of midwest manufacturers for a host of important lubricating jobs. Discover how STANOIL will give you superior protection through its unique combination of six outstanding characteristics, including high stability and effective rust prevention. Find how STANOIL can simplify stock, storage, and inventory in your plant by replacing special-purpose oils in hydraulic systems, speed reducers, air compressors, machine tools, electric motors, auxiliary turbines, and a wide variety of circulating, bath, and bearing systems. Ask the Standard Oil lubrication specialist from your nearby Standard Oil office for this booklet, or write: Standard Oil Company (Indiana), 910 S. Michigan Ave., Chicago.

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HERE'S HOW UNEEPAC WORKS

1. Lips are positioned diametrically and vertically by center section of sealing ring.
2. Spaces between lips and heels allow fluid pressure to act upon each lip.
3. Lips are protected by the projecting portion of center section against damage by excessive gland pressure.
4. Lips are supported to prevent collapse or distortion by excessive fluid pressure.
5. Each ring correctly centers itself on the preceding ring so that they align vertically and nest perfectly.

Uneepac

...the new Johns-Manville automatic ring packing

EQUIPMENT DESIGNERS are finding that this newest Johns-Manville packing development enables them to hold stuffing-box sizes to a minimum . . . thereby save both space and machining.

This ability of Uneepac to provide high sealing efficiency in minimum packing depth results from the fact that each ring is a complete self-contained packing unit. Uneepac is designed so that the center section of each ring positions the lips and protects them from excessive gland pressure. Header and follower rings are therefore seldom required.

In addition, Uneepac offers other advantages that are important both to the designer and the user:

SIMPLIFIED INSTALLATION—Each Uneepac ring centers itself on the preceding ring so that the entire set is aligned vertically and nested perfectly. This feature practically insures trouble-free installation.

MORE EFFICIENT SEALING—Because it is designed so that each lip is always exposed to fluid pressure, Uneepac has excellent pressure sensitivity . . . is instantly responsive to fluid pressure changes.

REDUCED FRICTION AND WEAR—The operation of this new automatic packing is completely independent of gland pressure. This reduces friction to a minimum—saves wear on both rod and packing—and contributes to longer life with corresponding reductions in down time for replacements.

Uneepac is available in sizes from 5/8" inside diameter to 63" outside diameter. For complete information, write Johns-Manville, Box 60, N. Y. 16, N. Y.

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Johns-Manville PACKINGS & GASKETS

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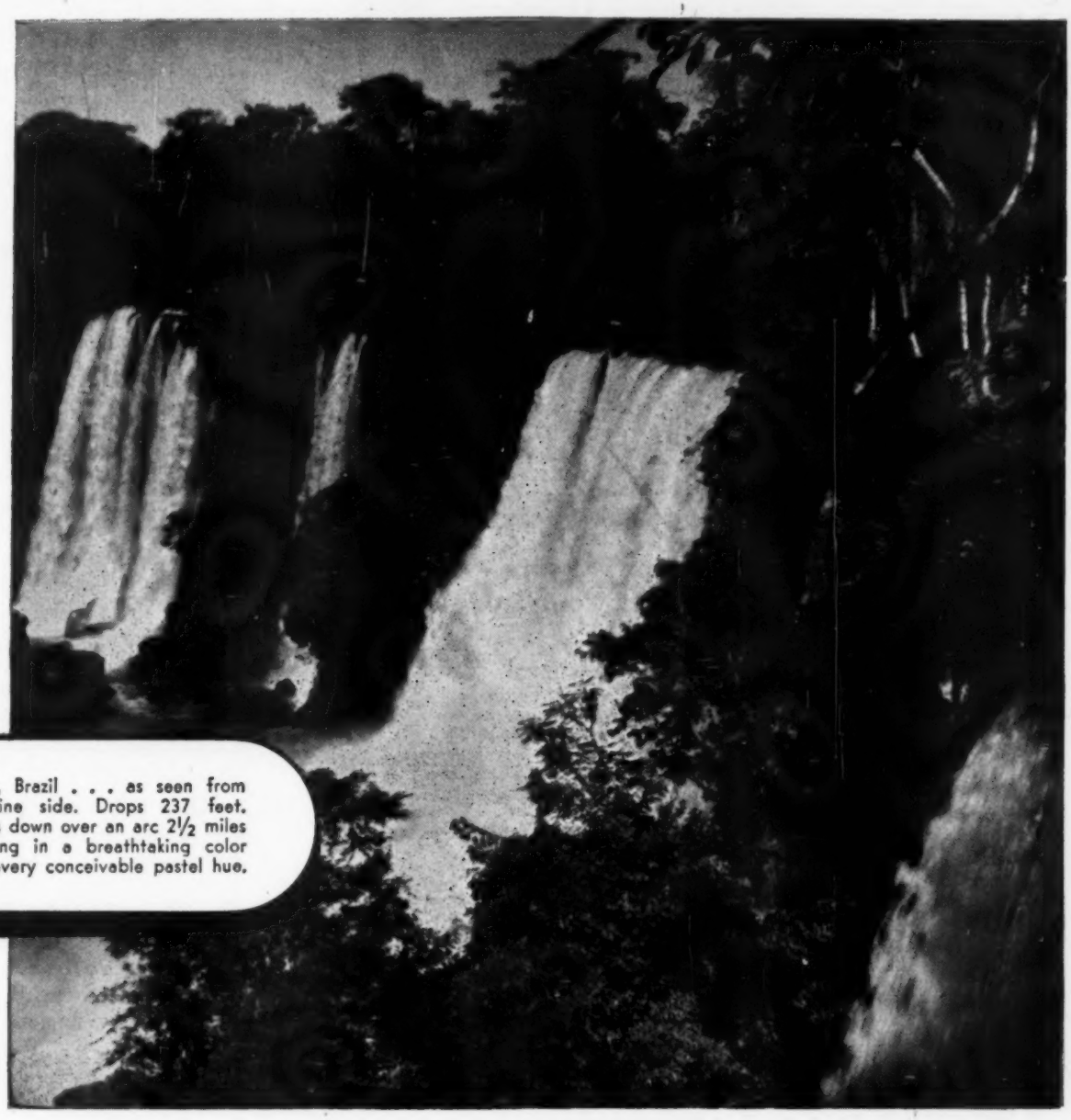

Igussu Falls, Brazil . . . as seen from the Argentine side. Drops 237 feet. Water swirls down over an arc 2½ miles wide resulting in a breathtaking color display of every conceivable pastel hue.

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POWER MOVEMENTS IN ANY DIRECTION — NO POWER UNIT REQUIRED

COMBINES

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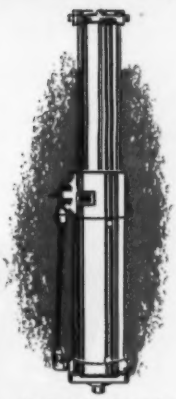
5 STANDARD MOUNTING TYPES

Standard bores from 3" to 8". Any stroke to 5 feet. For air pressures to 150 p.s.i.

Furnished for controlled feed with rapid return in either direction, or with controlled feed in both directions. Skip-feed movement can also be provided.



Air-Draulic Cylinder with Flange Mounting at Rod End

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SAVES TIME — Logan — AIR AND HYDRAULIC EQUIPMENT — EFFORT • MOTION

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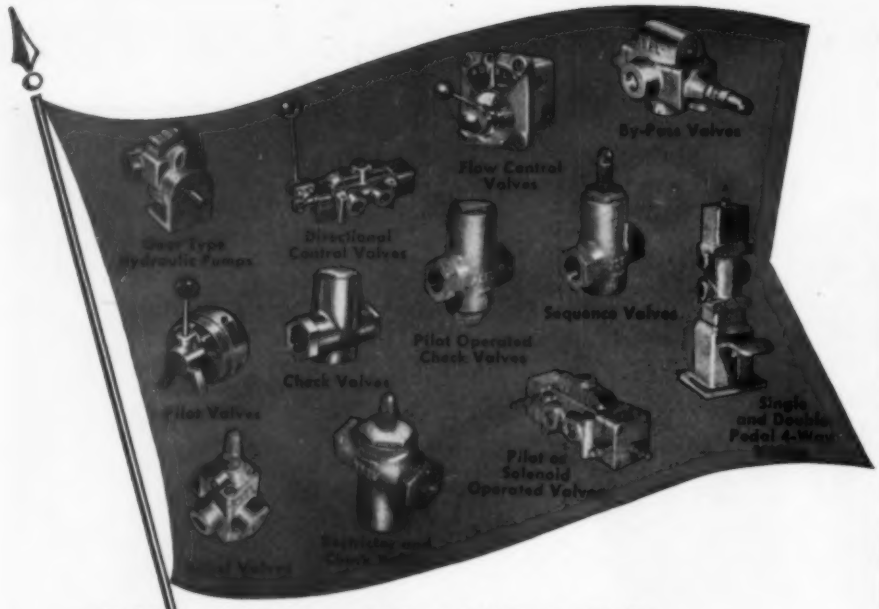

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Letters to the Editor

Continued

aircraft industry and are winning increased acceptance in industrial applications. A list of companies that make "O" rings and back-up rings is being sent to you.

Ways to Synchronize Cylinders

The air-oil combination cylinders, shown in the article "Have You Used This Circuit to Synchronize Cylinders?", page 110 or your April issue, is subject to the same criticism as the average manual hydraulic remote control (master and slave), in that both are subject to thermal expansion of the oil and to internal and external leakage; and so require additional corrective measures such as relief valves and, preferably, automatic replenishing and synchronizing means (check telemotors on ship's steering gear). Of course, no one system of automatic synchronizing cylinder (or hydraulic motor) operation, in pairs will fit all applications.

Many twin ram presses are single acting, cylinder operated. In such cases, each ram can be fed from a common source, divided through two good tight hydraulic pumps of equal displacement, with their shafts tied together. This method is subject only to the internal leakage, and is applicable to double acting cylinders as well or to independent driving motors. A great deal depends on the accuracy of the particular system at hand, i.e., the permissible error.

For a simple moderate error system, the all hydraulic equivalent of the diagram (page 110, April issue) with no air piston, but double rod cylinders, is to strike out one of the diagonal cross lines and connect these two (one top and one bottom) ports alternately to pressure and to tank. This is a series system and, while subject to the same criticism as the system shown, there is only one trapped volume.

A counterpart of the double pump flow divider is to use two low pressure motors of equal displacement (hence less internal leakage), their shafts, instead of being locked together, are connected to a differen-

Continued on page 18

proved

by 16,000,000 cycles

SNAP-LOCK TRADE MARK limit switches

Four out of five machine tool builders use Snap-Lock limit Switches. On some machines you'll find as many as 75 units.

That kind of acceptance is proof of dependability in use. But it's no surprise to us—we proved it to ourselves first—by putting a Snap-Lock on breakdown test. The test machine got tired after 16,000,000 cycles—the Snap-Lock was still going strong.

That's why we say, when you're looking for a dependable limit switch—look to Snap-Lock. May we help you engineer them for your particular job?

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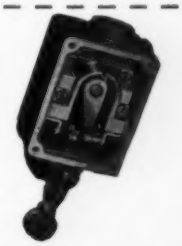
Accessible wiring connections, self wiping coin silver contacts, no arcing, heavy insulation throughout, oil and dust resistant case. Single pole, double break, double throw— positive lock in ON or OFF position.



MECHANICAL FEATURES

Hardened steel parts, strong spring, rugged, compact construction, wide choice of operating levers. Snap-Lock is guaranteed mechanically and electrically for any normal circuit application.

ENGINEERING BULLETIN EM-51

gives complete engineering specifications for all types of standard Snap-Lock switches, styles of mountings, operating levers — or better still, ask our engineers to cooperate with yours on special applications.

YOUR SEAL OF

TOP PERFORMANCE!

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Our latest packing developments help you increase efficiency.

A good example of Houghton's recent achievements in packing design is our new No. 1243-3—Synthetic *rubber impregnated* VIM Leather Cup Packings with qualities never before equalled! These packings combine leather's long life and low-friction coefficient with rubber's non-porous, heat resistant, resilient qualities. They are flexible, easily installed, provide leak-proof seals from 0 to 15,000 lbs. pressure, and withstand temperatures from —65° F. to 200° F. Two exclusive design features make these packings, in effect, "pre-loaded" and prevent deformation under pressure.

Our new Vix-Syn plant promises you stepped-up delivery.

When the growing demand for synthetic rubber packings called for expanded facilities, this additional, newly-constructed Vix-Syn plant was our answer. This modern plant was erected for Vix-Syn Synthetic Rubber Packings and precision molded rubber products exclusively. It is already turning out standard size homogeneous commercial packings in increasing quantities to supply the growing needs of the expanding hydraulic market.

Get Houghton's "Packing Standards" Book, illustrated. It is accepted as the standard by industry, and will be mailed without cost on request. Houghton was first to compile complete packing handbooks and to offer simplified standards to industry. For "Packing Standards" booklet, write: E. F. Houghton & Co., 303 W. Lehigh Avenue, Philadelphia 33, Pa.

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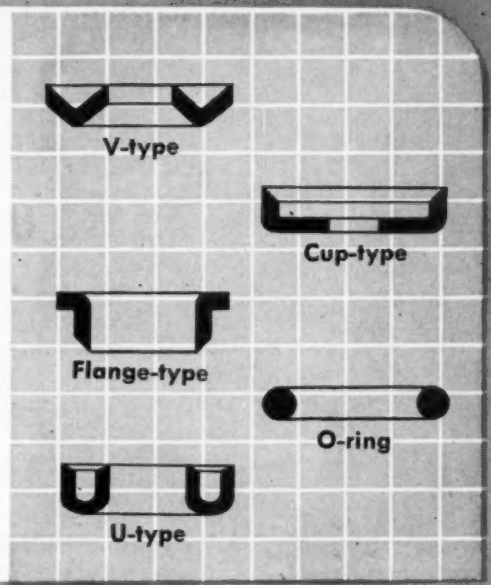
VIM LEATHER PACKINGS—Cup, flange, "U" and "V" types and back-up washers for use with "O" rings—for oil, air, water or gas applications—used for all pressures and for temperatures up to 200° F.

VIX-SYN SYNTHETIC RUBBER PACKINGS—Including homogeneous and fabricated packings, gaskets and adaptors—also "O" rings—both packing and gasket types.



Our expanded field service helps you solve design problems.

You'll find trained Houghton engineers in every industrial center, well equipped to help you with hydraulic and pneumatic packing problems. Call them with confidence for original packing designs. Or enlist their aid in recommending improvements on existing designs. They are backed up by a knowledge gained over 44 years of engineering service to designers.

VIM and VIX-SYN PACKINGS

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Ready to give you on-the-job service . . .

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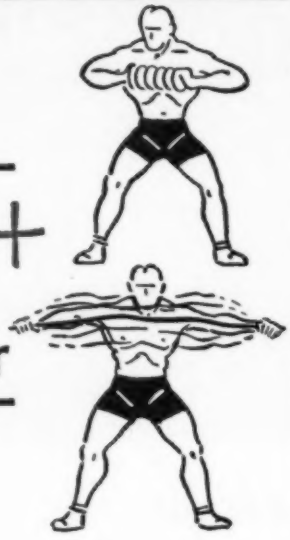
WIRETEX AIR HOSE

Strength of Steel
PLUS +
Flexibility of Rubber



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WIRETEX, combining the strength of steel with the flexibility of rubber, brings you economical hose performance. Republic WIRETEX Air Hose easily handles air pressures up to 2,000 psi — and is ideally suited to work on less rigorous jobs, too, where extra service life and trouble-free performance is an asset.

Republic WIRETEX is NEW — a truly modern conductor internally reinforced with high tensile wire. It's easy to handle, unbelievably tough and long lasting. What's more, Republic WIRETEX is built in 60-foot **Economy Lengths.** You save money when you buy Republic WIRETEX; time and money when you use it! Get the facts today! Republic WIRETEX Hose is available in all standard (⅜" to 2" inclusive) sizes.

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INDUSTRIAL RUBBER PRODUCTS

Letters to the Editor

Continued

tial, the third member of the differential being connected to a four-way valve, which controls whichever cylinder is to be made the "slave". In this case, the motors are connected to the discharge side of each cylinder, acting as meters, developing only enough torque to operate a valve.

This basic method can be amplified and improved by adding response feed-back error correction, if rates and positions of the piston rods are to be variables. However, when one goes this far, two cylinders, each fed through a conventional three-way or four-way valve, motivated through a differential, the arms of which are "signal" and "response feed-back", will accomplish the same. A single signal will keep both cylinders moving in synchronization.

From this point we can go to two of the Vickers Steering Booster Cylinders, with the control points attached to a single manual signal. We are right back at the start, with the all hydraulic equivalent of the Diagram (Page 110), but with no thermal or leakage problems. So having completed the circle, it is obvious that the paramount factors are the particular application, the permissible error, and how much money the machine manufacturer or purchaser is willing to spend.

R. B. GALLOWAY,
Washington Office,
Vickers, Inc.

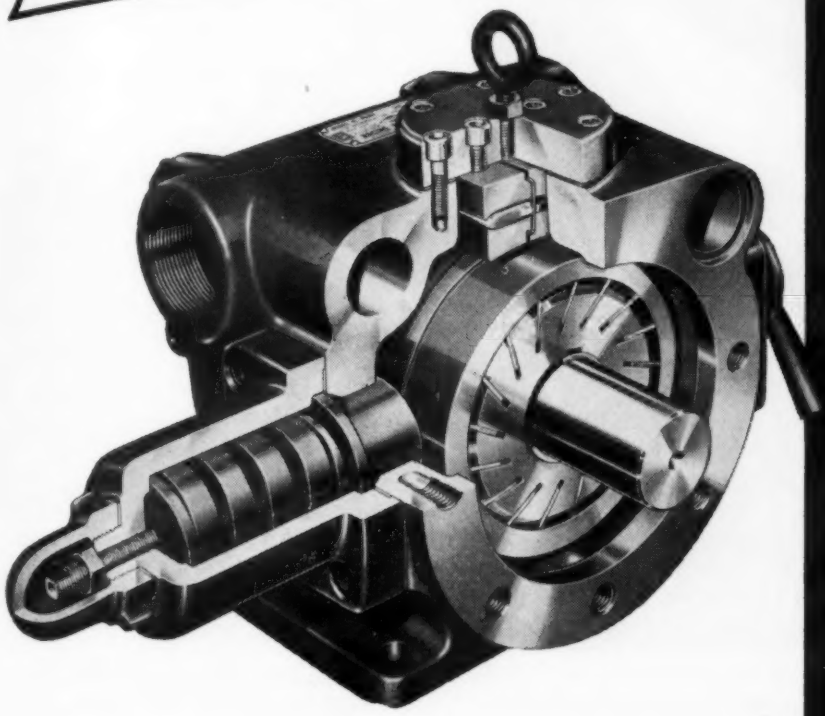
Thanks, Mr. Galloway, for your very interesting analysis. In effect, the application always dictates just what combinations of equipment is necessary. The user is interested in the simplest basic elements he requires to do the job efficiently and economically. Editor's note: We are always interested in comments on articles published. They are helpful in planning material for future issues.

A Switch Error

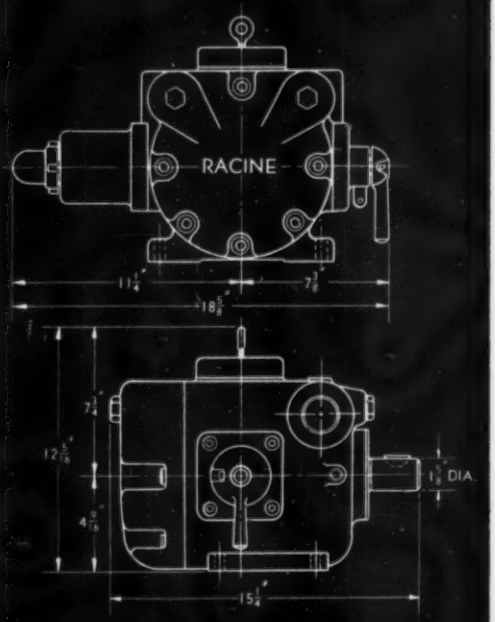
I have read with great interest your article "Electronic Instrumentation" in the April 1953 issue

Continued on page 20

New RACINE 70 gpm VARIABLE VOLUME PUMP



- ★ 70 GPM AT 1200 RPM
- ★ VARIABLE VOLUME
- ★ PRESSURE COMPENSATED GOVERNOR
- ★ LEVER VOLUME CONTROL
- ★ FOOT MOUNTED
- ★ MAX. WORKING PRESSURE—1000 PSI



This new Model K 70 gpm Variable Volume Oil Hydraulic Pump is an important addition to Racine's broad line of hydraulic products. It is equipped with a pressure compensating governor which automatically regulates the maximum pressure to the hydraulic system and provides safe and adequate over-pressure protection.

An additional manual lever control regulates the volumetric output of the pump to meet circuit requirements.

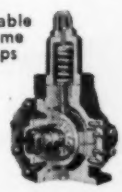
Write for complete descriptive catalog on Model K 70 gpm Oil Hydraulic Pump

BUY DEFENSE BONDS

OTHER RACINE HYDRAULICS PRODUCTS

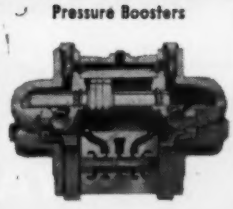
Four-Way Valves

Variable Volume Pumps



Power Units

Pressure Boosters



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. . . for Trouble-free Hydraulic Service

Now, the United States Gasket Company offers you one source of supply and undivided responsibility in a complete line of synthetic rubber "O" Rings and companion Teflon* Back-up Rings for all military and commercial requirements.

- **CHEMISEAL "O" RINGS** of resilient, homogeneous synthetic rubber are absolutely non-porous and withstand a wide temperature range. They are available in both commercial and AN compounds.
- **CHEM-O-GREEN BACK-UP RINGS** are made of chemically inert duPont Teflon, colored green for identification purposes. They are made in three types, solid rings, split rings and the popular improved spiral type which adjusts itself to the groove and, on compression, becomes in effect, a solid ring of the required diameter and thickness.

The advantages of Chem-o-green (Teflon) Back-up rings are many.

Chemical inspections may be eliminated as Teflon is non-corrosive. Zero swelling in all hydrocarbons or newer synthetic hydraulic fluids or solvents. Service temperature range from minus 110° F to 500° F. Unsurpassed anti-friction properties. Water-proof, non-flammable. Long wearing. Requires no water-soak for installation.

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Letters to the Editor

Continued

of APPLIED HYDRAULICS. Will you please send me a set of "tear sheets" of this article as I have to pass the magazine on to others to use. It appears to me the diagrams on page 65 have been switched as they do not agree with the descriptions.

H. M. VAUGHAN,
Richmond Engineering Co., Inc.
Richmond, Va.

Thank you, Mr. Vaughan. You are correct. The diagrams on page 65 were switched. Measurement of dynamic phenomena requires an AC amplifier.

"Multi-Slide" is a Trade Mark

We have been advised that the term "Multi-Slide" which was used in the title of an article in the March issue ("Electro Hydraulic System for Multi-Slide Turning Machine") is a coined word originated by and registered by U.S. Tool Company, Inc. of Ampere, N.J.

A Source for Large Size, High Pressure Air Valves

In reference to questions by Mr. G. H. Elder, Jr., page 16, and Mr. J. H. Millar, page 20, both of the April issue of APPLIED HYDRAULICS, I would like to call the attention of both gentlemen to the high pressure, high temperature valves made by Hoppe Engineering Co., Inc., of Greensboro, Ind. This company specializes in developing and building custom made valves for such service and to specifications.

CLYDE H. POTTER,
New York 38, N.Y. and
Lynbrook, L.I., N.Y.

Thanks, Mr. Potter. We believe a number of our readers, in addition to Messrs. Elder and Millar, will be interested in this source for high pressure, large size components for handling air (Mr. Elder's question) or low leakage, high pressure (6000 psi) air valves (Mr. Millar's question).

We also had a letter from John F. Crane, Manufacturing Development

Continued on page 24

"EUCS" get down to earth with HYDRECO Oil Power

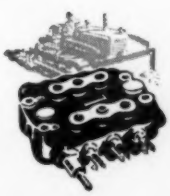
New 51,900-pound, 15.5-yd. Lever Scraper, made by the Euclid Road Machinery Company, Cleveland, has hydraulic system that uses levers instead of cables and sheaves—eliminates 90 feet of control cable. Controls are faster acting, more accessible for servicing.

THE Euclid Lever Scraper puts powerful hydraulic muscles to work when it digs into tough jobs. In getting down to earth, muscles can't work alone: they must have a heart to feed them and a brain to control them. That's where HYDRECO Oil Power goes to work.

The "heart" of this "EUC" is the HYDRECO Gear-type, Four-Bolt Pump. There's no danger of heart failure here, because the pressure is confined inside a minimum space to reduce distortion.

The HYDRECO Hollow-Plunger Valve is the "brain" behind the power. It controls movement of the bowl, apron and ejector . . . provides constant pressure rise from neutral to full open position . . . retains pressure during shifts in positions.

Let HYDRECO Engineers get down to earth on your special problems. Write for bulletin on pumps and valves from 1/2 to 150 gpm and for operating pressure up to 1500 psi; fluid motors to 60 hp; and cylinders up to 8 inches effective diameter.



HYDRECO A DIVISION OF THE NEW YORK AIR BRAKE CO.

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25 NEW HYDRECO DISTRIBUTORS:

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Georgia
J. A. Postell Co.
936 W. Peachtree St., N.W., Atlanta

Illinois
Walter Norris Engineering Co.
20 N. Wacker Drive, Chicago

Indiana
Tec Engineering Co.
Logansport (Branches: Indianapolis and Muncie)

Maryland
Colliflower, Inc.
Baltimore National Pike
East of Rogers Ave., Ellicott City

Massachusetts
Compressed Air Products (Branch)
Harkness Rd., Amherst

Minnesota
J. M. Grimstad (Branch)
2943 Nobel Ave., Minneapolis

Missouri
Ar-Ka Engineering Co.
1315 S. Vandeventer St., St. Louis

New Jersey
Compressed Air Products
1977 Springfield Ave., Maplewood

New York
R. C. Neal Co.
76 Pearl St., Buffalo
(Branches: Rochester and Syracuse)

Compressed Air Products
6 Church St., New York

Ohio
Henry M. Wood Co.
920 E. McMillan St., Cincinnati
(Branch: Columbus)

Hydraulic Power Equipment Co.
Box 431, North Lima

Pennsylvania
Erie Industrial
1005 W. Sixth St., Erie

The Battersby Co.
3701 N. Broad St., Philadelphia

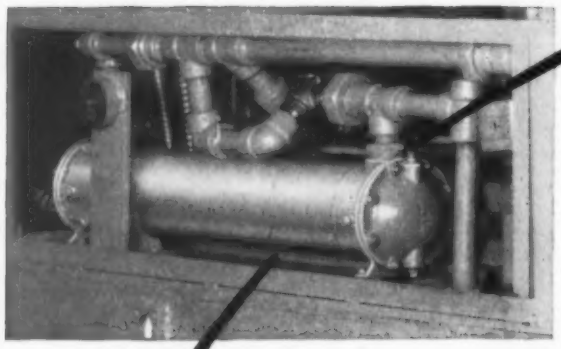
Texas
Lynn Elliott Co.
371 M & M Building, Houston
(Branch: Dallas)

Utah
Specialty Sales Co.
208 W. Temple St., Salt Lake City

Wisconsin
J. M. Grimstad
8320 W. Bluemound Rd., Milwaukee

Canada
C. M. Lovsted Co.
1016 Mainland St., Vancouver, B. C.

For hydraulic fluid temperature safety in this H-P-M die casting machine



IT'S ROSS EXCHANGER EQUIPPED

Applying die clamping pressures up to 400 tons at top capacity and producing aluminum alloy castings weighing up to 12.2 lbs., this H-P-M Die Casting Machine is reportedly "putting the squeeze" on production costs.

. . . and one of the ways it's doing it is by holding hydraulic fluid temperatures in check. No lost capacity through pump slippage on *this* machine! A built-in Ross Type BCF Exchanger is furnished for just that purpose. Overheating is effectively prevented. Productivity is insured!

Like H-P-M, a user of Ross Exchangers on many of its products, so are *most* progressive machinery manufacturers furnishing this same, reliable, temperature-safeguard.

Their reasons . . . *summed up:* Ruggedness that withstands hydraulic shock — tough, ductile, seamless copper shell and brass forgings that can *take* the extra load. Compactness. A wide range of pre-engineered, fully standardized designs and sizes to meet most requirements.

More facts are in Bulletin 1.1K5. Write for your copy.

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1464 WEST AVENUE • BUFFALO 13, N. Y.
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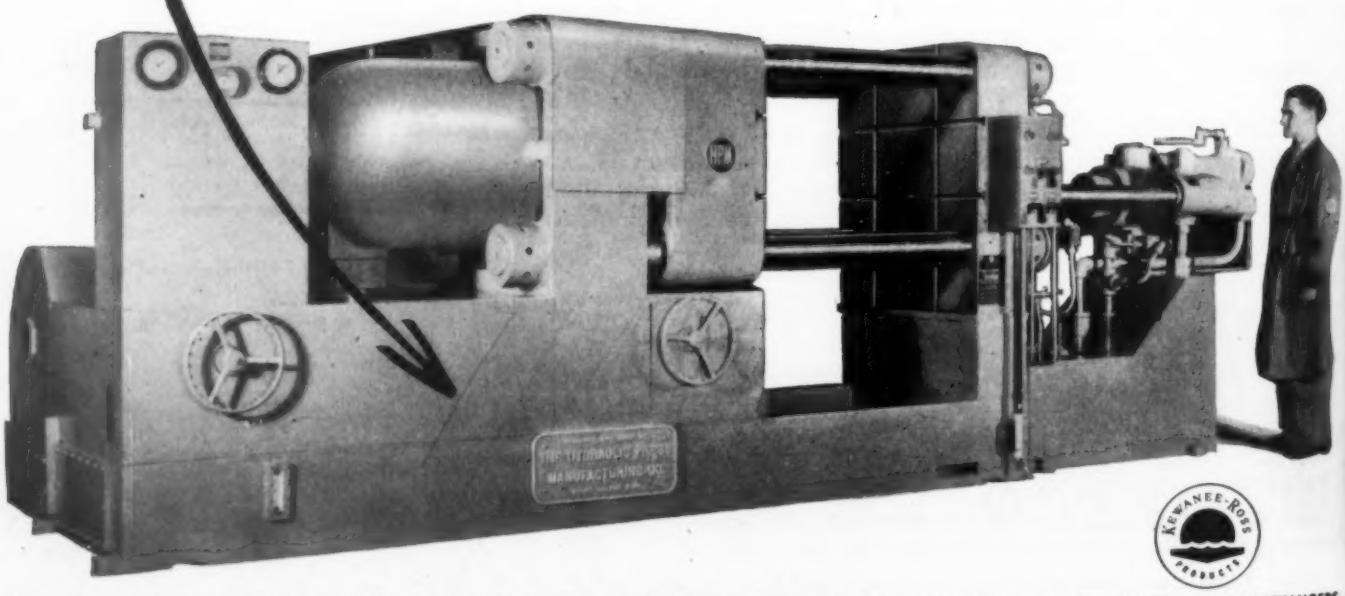

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VICKERS *Greyhound Specified* HYDRAULIC POWER STEERING

on 400 New Coaches

Always searching for ways to further increase passenger safety, Greyhound Lines selected Vickers Hydraulic Power Steering for the 400 new Model PD-4104 GM Coaches recently purchased.

Vickers Hydraulic Power Steering prevents the possible loss of driver control when a vehicle is forced off the pavement onto a soft shoulder . . . or when a front tire blows out. Extra steering power and quick maneuverability are always available for emergency conditions.

The Vickers System absorbs all road shock and transmits it to the vehicle frame . . . there can be no kick-back at the steering wheel. The driver supplies only enough effort to slightly move a servo valve . . . fatigue is thus greatly reduced and the driver is more alert.

Only minor alterations are usually required to incorporate Vickers Hydraulic Power Steering in new and existing vehicle designs. For further information, ask for new Bulletin M-5104.

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VICKERS *hydraulic*
POWER STEERING
is Effortless
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6231

Vickers Hydraulic Power Steering Booster does the actual work of steering

Engine-driven Vickers Vane Pump (with integral volume control and relief valves, and oil reservoir) supplies power for steering.

ENGINEERS AND BUILDERS OF OIL HYDRAULIC EQUIPMENT SINCE 1921

Keep your hydraulic oils, and coolants clean with . . .

SPARKLER FILTERS

designed specifically for this purpose. A practical protection for hydraulic machinery and cutting tools

The VR filter is designed for filtering hydraulic oil, quenching oils, transformer oil, solvents and other industrial liquids.

The Sumptype filter is ideal for filtering coolants. The filter plate assembly is attached to the intake pipe of the circulating pump and the coolant is drawn through the filter discs and delivered clean and free from all metal particles and grit, to the nozzels.

★ Clean hydraulic oil greatly prolongs the life of all moving parts, such as pistons, cylinders, pumps, valves, etc.

★ Filtering hydraulic oil extends the life of the oil. Drain and leakage oil may be reclaimed. One large user of hydraulic machinery saved $90,000.00 in hydraulic oil alone in one year by filtering oil with Sparkler Filters.

★ Filtering hydraulic oil eliminates sticking and clogging of valves and reduces down time and maintenance cost. A prominent authority on hydraulic machinery says that 70% of servicing and repairs is due to the improper condition of hydraulic oil.

★ Filtering coolant fluid removes all fine metal particles and grit from grinding wheels that is pumped back to nozzles unless a filter is employed in cleaning up the return coolant.

★ Clean filtered coolant prevents scratching and flat spots on work piece and increases the life of grinding wheels and cutting tools. Reduces the frequency of dressing grinding wheels.

The Sparkler VR filter is constructed on a simple filtering principle using filter paper as a media. The filter plates can be removed easily for cleaning which consists only of removing the dirty paper and replacing with fresh sheets. Any shopman can make this change of paper in a few minutes. The cost of replaced paper is less than a dollar per change.

Let a Sparkler representative demonstrate these filters in your plant

SPARKLER MANUFACTURING CO.
Mundelein, Ill.

REPRESENTATIVES IN ALL PRINCIPAL CITIES

Letters to the Editor

Continued

Group, Manufacturing Engineering Dept., of Consolidated Vultee Aircraft Corporation, in which he suggests to Mr. Millar that Barksdale Valves, 4905 Sante Fe Ave., Los Angeles 58, Calif., makes valves to handle air at 6000 psi.

Revised JIC Standards

Our works in Germany have requested us to secure a copy of the J.I.C. Hydraulic Standards for Industrial Equipment.

R. F. STEINHAUER,
President,
Heller Machine Co.
New York City

It happens that the new revised J.I.C. Hydraulic Standards for Industrial Equipment, dated June 1, 1953, has just been released. Copies may be obtained by addressing Joint Industry Conference, P.O. Box 182, Northend Station, Detroit 2, Mich.

Hydraulic Pressure Proportional to Solenoid Voltage

We have been searching for a solenoid operated valve which would regulate hydraulic pressure proportional to the voltage applied to the solenoid; but have been unable to locate this as a standard item. Do you know of any manufacturers who make such a valve as a standard item?

J. A. RIDER,
Johnstone Engineering & Machine Co.
Parksburg, Pa.

We checked with several electrical people and our files of electrical components and don't find such an item. We were told, however, that such a valve may be operated by a pressure switch, the motor operated by electrical relays. In the latter case, the standard relay operates at a 10 percent of the name-plate marking or a voltage sensitive relay will operate at a 5 percent of the name-plate marking of line voltage. The voltage sensitive relay will open at a definite voltage and close at a definite voltage. This is, apparently,

Continued on page 28

In hydraulic systems

SUNTAC CUTS LEAKAGE AN AVERAGE OF 35%

This amazing average has been established by years of extensive use in many different industrial hydraulic systems. And results are immediate—leakage is reduced as soon as Suntac Oil is put in the system.

For information about Suntac for your specific application, telephone your nearest Sun office or write SUN OIL COMPANY, Philadelphia 3, Pa., Department AH-7.

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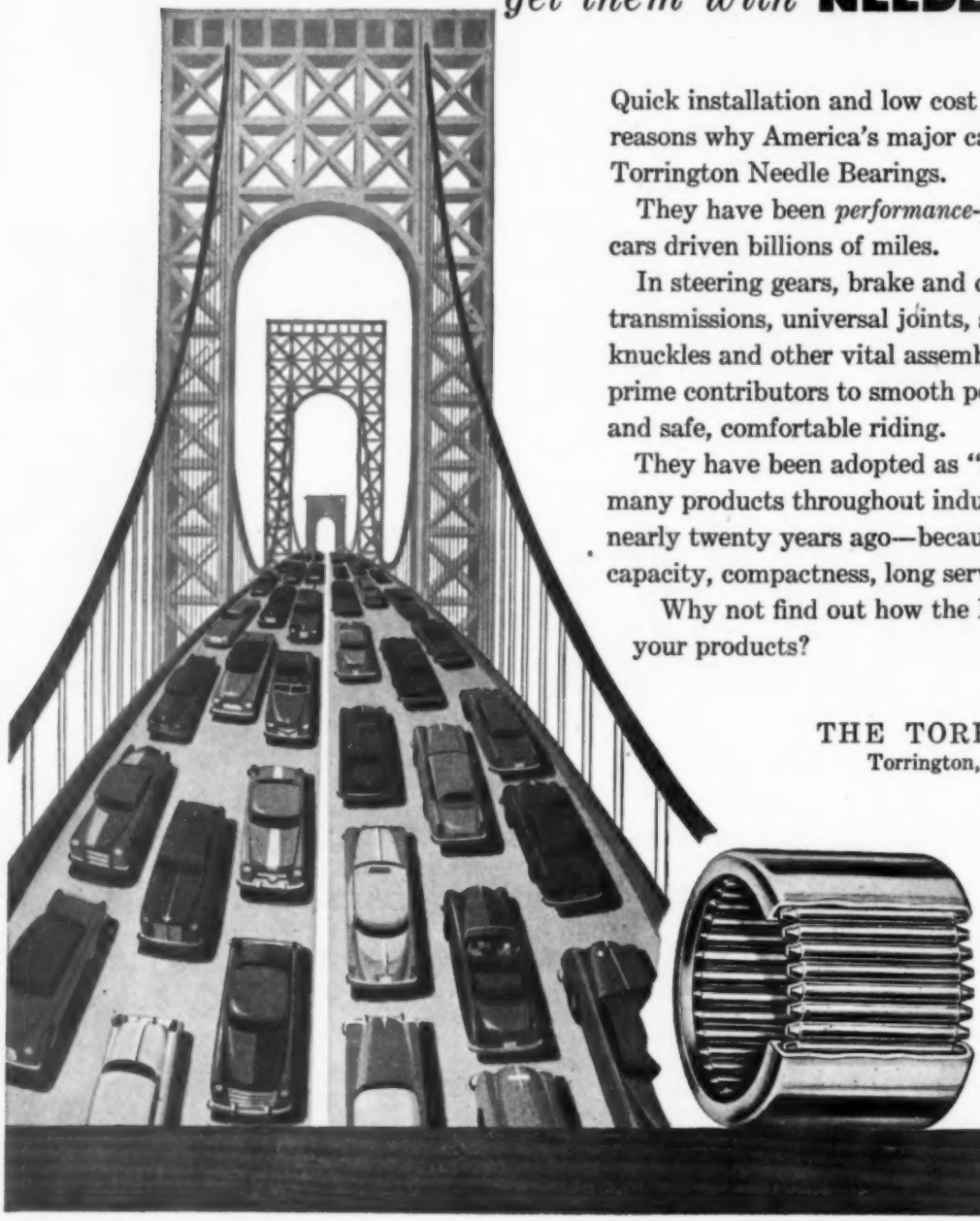
Are Easy Assembly and Low Cost "Musts" for You?

Here's how leading automobile manufacturers get them with NEEDLE BEARINGS



Quick installation and low cost are just two of many reasons why America's major car manufacturers use Torrington Needle Bearings.

They have been *performance-proved*, too, in millions of cars driven billions of miles.

In steering gears, brake and clutch linkage pivots, transmissions, universal joints, steering idlers, steering knuckles and other vital assemblies, Needle Bearings are prime contributors to smooth performance, easy handling, and safe, comfortable riding.

They have been adopted as "standard equipment" in many products throughout industry since their introduction nearly twenty years ago—because of their high radial capacity, compactness, long service life and low cost.

Why not find out how the Needle Bearing can improve your products?

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Trade Marks of 12 of the 18 passenger car manufacturers, all of whose cars enjoy the benefits of Needle Bearings.

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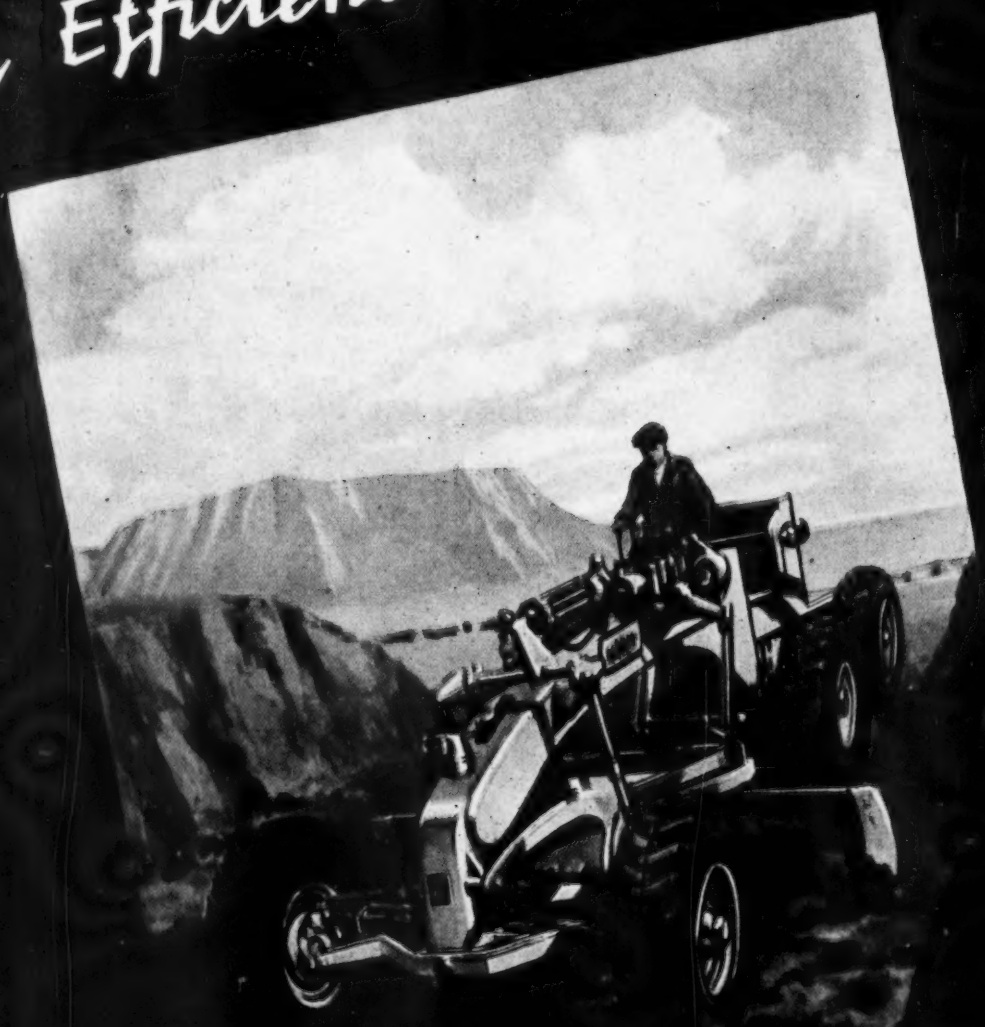
For Efficient Power Transmission



The "CARLISLE" GRADER
KEELAVITE HYDRAULICS GIVE EFFICIENT TROUBLE-FREE CONTROL
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Keelavite hydraulics

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Leather Oil Seals

Rigid laboratory control PLUS 100% inspection assures *Consistent Quality*

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When the reputation of a product depends on the unfailing performance of a seal . . . you need *quality you can trust.*

Here, at Trostel, quality control procedures are an integral part of the packings specification itself . . . and these carefully worked out procedures are rigidly enforced during processing and manufacture by one or more of *three* separate laboratories. Then, to make doubly sure, each individual packing and oil seal must pass a comprehensive visual inspection before it can be released for shipment.

We invite you to join the growing list of major equipment manufacturers who know from their own experience:

"You can trust a Trostel seal."

Illustrated Bulletin On Request

ALBERT TROSTEL PACKINGS, LTD., Lake Geneva, Wis.

Formerly Division of Albert Trostel & Sons Co., Milwaukee, Wis.

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WORCESTER, MASS.

TROSTEL QUALITY

TROSTEL mechanical packings

Letters to the Editor

Continued

as close as possible you can get to a proportional voltage for a solenoid in standard equipment.

We Were Wrong

In the December 1952 issue of your journal in the Fluid Power Lines page a paragraph stated that "the availability of an oil power unit which can be used interchangeably as a pump or motor without changing internal parts is new." I would point out that Keelavite Rotary Pumps & Motors Ltd. has been manufacturing and marketing such a unit covering duties from fractional to 75 hp for over 16 years and respectfully suggest that the above statement is corrected in a forthcoming issue.

H. H. ROWLAND,
Sales Department
Keelavite Rotary Pumps
& Motors Limited
Allesley, Coventry

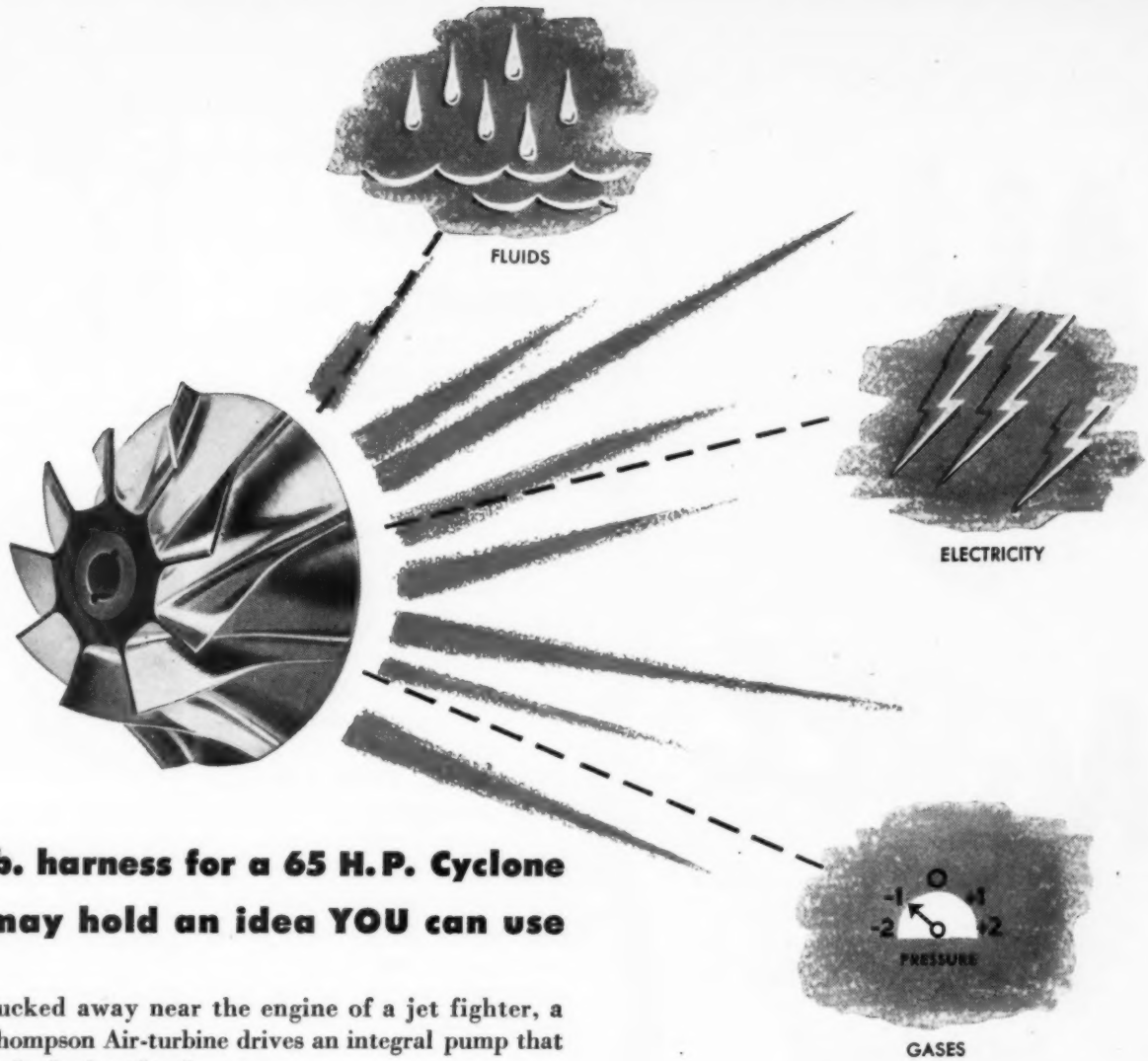
The Fluid Power Lines item referred to John English's article in that issue. Mr. English described a new vane type pump-motor. We failed to identify the new pump/motor as a vane unit in the note. To further clarify the distinctive place that Keelavite has in the pump-motor field, we have included a short description of the rotary abutment pump-motor elsewhere in this issue.

Heavy Duty Jacks

Do you know the name of any hydraulic house moving jack now in use on the West Coast? We will appreciate the name and address of the manufacturer of such a jack.

GILMER GILBERTSON,
Modern Equipment Co.
Minneapolis, Minn.

There are several manufacturers who distribute nationally and can furnish heavy duty jacks. Vard, Inc. of Pasadena, Calif. makes a line of ball screwjacks. At least one leading distributor on the West Coast has had a good deal of experience with special heavy duty jacks. We suggest you get in touch with Haskel Engineering & Supply Co., 721 West Broadway, Glendale 4, Calif.



This 12 lb. harness for a 65 H.P. Cyclone ...may hold an idea YOU can use

Tucked away near the engine of a jet fighter, a Thompson Air-turbine drives an integral pump that feeds the jet after-burners.

Coupled to an electrical alternator, a Thompson Air-turbine drive delivers vast amounts of horsepower at micro-precise speed, regardless of fluctuations in load.

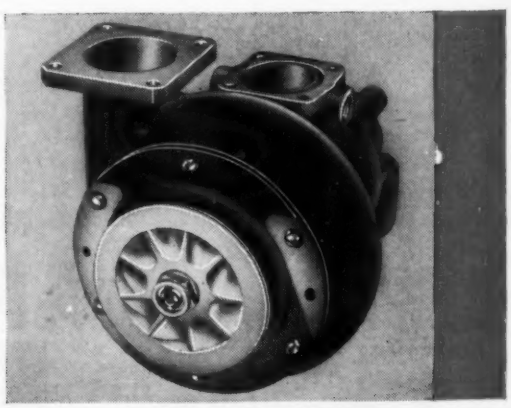
These Thompson turbines pack abundant power into small space, with minimum weight. What's more, they use air, always available at low cost.

Industry is discovering dozens of new uses for these Thompson Air-turbines . . . in a wide range of sizes and power. You may find it worth-while to call in a Thompson representative to tell you what we know about designing and building Air-turbines. To find out how you can put them to work in *your* application, present or future, write . . .

ACCESSORIES DIVISION

Thompson Products, Inc.

Cleveland 17, Ohio



12-pound, 65-HP Air-Turbine-driven Pump

ALL 3 AGREE

ON MARVEL *Synclinal* FILTERS

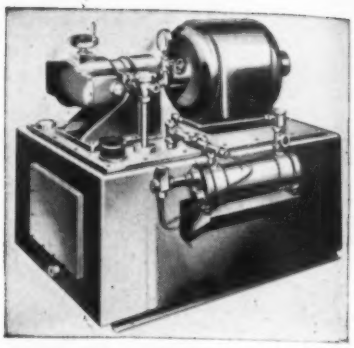
DESIGNERS

PRODUCTION MEN

MAINTENANCE MEN

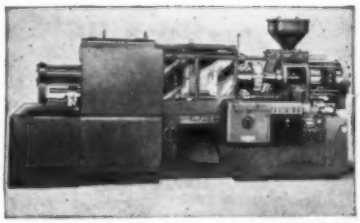
The regularity with which Marvel Synclinal Filters are selected by DESIGNERS—PRODUCTION MEN—MAINTENANCE MEN is an important consideration for you when selecting a FILTER for your machinery. It tells better than a thousand words why you can rely on MARVEL Synclinal Filters for dependable protection of liquids in all HYDRAULIC and LOW PRESSURE SYSTEMS.

It's sound business to protect the investment your machinery represents. Why not ask Marvel how you can enjoy the protection of Marvel Synclinal Filters—no cost or obligation to get the facts.



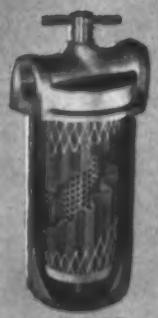
Large series hydraulic pumping unit manufactured by The Denison Engineering Co., are equipped with Marvel Synclinal Filters.

Model A-12 Hufford Stretch-Wrap Forming Machine manufactured by Hufford. Marvel Synclinal Filters are installed as standard equipment.



Reed-Prentice injection molding machine used at Superior Plastics, division of Commonwealth Plastics, Inc. are equipped with Marvel Synclinal Filters.

2½ TIMES MORE *ACTIVE* FILTERING AREA!



LINE TYPE (Cutaway)

Marvel Synclinal Filters are winning new laurels for performance with an ever-widening number of users. OVER 300 ORIGINAL EQUIPMENT MANUFACTURERS specify Marvel Synclinal Filters for protection to collant and lubricating systems. Fine and large foreign particles which have an abrasive action on bearings or impair flow orifices are filtered out with Marvel Synclinal Filters.

Available in sump and line models, in capacities of 5 to 100 G.P.M., and in wire mesh sizes from 30 to 200. Multiple installations provide capacities as great as you may require. Both models are easy to disassemble, clean and reassemble. Line types operate in any position and may be serviced without disturbing pipe connections.

WATER FILTERS—Both our sump and line type models have been adapted for use in all water filtering applications. No changes have been made in the basic Synclinal design.

SUMP TYPE (Cutaway)

Write for Complete Engineering Data

—Specify Oil or Water

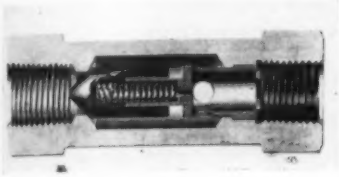
MARVEL *Engineering Company*

Meets J.I.C. Standards

625 WEST JACKSON BLVD., CHICAGO 6, ILLINOIS

NEW PRODUCTS

Components, tools and equipment designed to improve operation of fluid power systems are described here . . . for more information fill in and mail the post card bound in this issue.



CHECK VALVE
. . . features low pressure drop

Design: One piece aluminum body construction with a nylon poppet reduces overall weight and assures leak-proof trouble-free service.

Features: This check valve has a minimum pressure loss at rated flow for a given line size.

Sizes: Available in ⅜, ½, ¾ and 1 inch pipe sizes.

Applications: For use in oil, air and water with working pressures to 3000 psi.

Waterman Engineering Company
Evanston, Illinois

Circle 201 on Reader Service Card

GEAR PUMP
. . . for pressures to 1200 psi

Designation: HB Series.

Features: This series is available in three sizes with capacities ranging from one and eight-tenths to two and nine-tenths gpm at 1800 rpm and 1000 psi. Pressures or speeds in excess of these may be used satisfactorily in selected applications. An internal relief valve is optional and is adjustable for pressure between 500 and 1200 psi. This valve cannot be used as a control or pressure-regulating valve.

Applications: For agricultural implements, industrial trucks, agricultural and industrial power steering systems, tractor loaders, machine tools and construction machinery.

Webster Electric Company
Racine, Wisconsin

Circle 202 on Reader Service Card

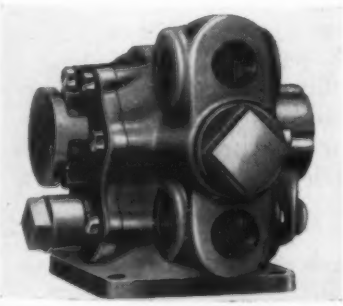
HOSE LINES
. . . for use with flareless tube connectors

Designation: Globe-Seal.

Design: Made up with detachable, reusable fittings, the hose-fitting nipple mates with Ermeto or Ferulok tube connectors without the need for ferrules or inserts. The new hose line is available in both the single and double wire braid types. Fitting consists of two pieces, a standard hose socket and the new nipple.

Aeroquip Corporation
Jackson, Michigan

Circle 203 on Reader Service Card



DIRECTIONAL VALVE
. . . has rotary spool design

Designation: Type 555-RO.

Specifications: Design pressure 300 psi to 1500 psi, capacity approximately 400 gpm at 1500 psi. Net weight 35 lbs.

Construction: Cast special alloy body and rotary valve. Check and relief valves and seats of special hardened stainless steel alloy. Ball bearing construction on rotary valve.

Features: For providing a simple inexpensive, and reliable self-contained valve mechanism to position double acting hydraulic cylinders, or hydraulic motors. This valve may be used to operate one, two, or three hydraulic cylinders.

A. W. Cash Company
Decatur, Illinois

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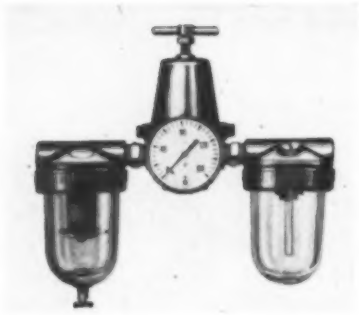
Continued

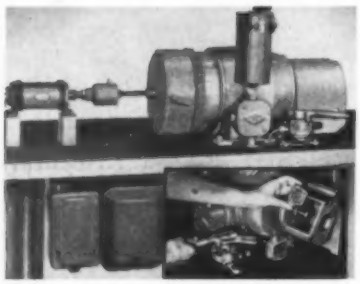


FILTER-REGULATOR-LUBRICATOR
. . . for air circuits

Operation: Has porous bronze element which has the ability to retain on its outer surface a much greater amount of sediment without a serious loss of pressure. Air or filtrate enters the unit where centrifugal action throws the moisture and heavier solids against the bowl and downward into a relatively quiet zone below the baffle where it is deposited.

Application: Has been designed to deliver into the air stream a finely vaporized mist of oil that remains in suspension and provides positive lubrication to the precision working parts of air operated equipment.

Arrow Tools, Inc.
Chicago, Illinois
Circle 205 on Reader Service Card



ELECTRIC MOTOR
. . . has through-shaft magnetic brake

Features: Magnetic brake design permits the motor shaft to be extended entirely through the brake. This eliminates the conventional dead ending of one end of the motor shaft within the brake. The shaft passage is thereby kept open for rams and punch out rods, which can pass entirely through the motor and brake. Brake permits fast, automatic starting and stopping for the repeated insertion and removal of work.

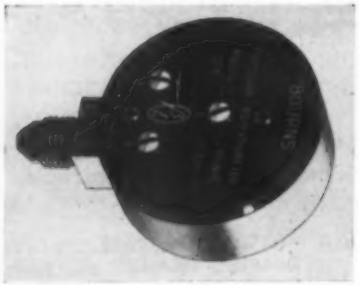
Reuland Electric Company
Alhambra, California
Circle 206 on Reader Service Card

BONDING PROCESS
. . . for rubber to metal

Designation: Permadizing Process.

Features: This technique offers a rubber-to-metal material whose dimensional tolerances can be held as closely as metal, as fine as 5 micro-finish. The process eliminates harmful flash and flaring of rubber and bonding agent on metal inserts, minimizes rejections and wasteful costly rework. The bonded parts are available for operation in a wide range of temperatures exhibit extremely low swell, are highly resistant to aromatic fuels and hydraulic fluids and have a steel-smooth precision finish. Permadized parts can be successfully made corrosion-resistant.

Stillman Rubber Co.
Culver City, California
Circle 207 on Reader Service Card



PRESSURE POTENTIOMETERS
. . . for remote measurements

Designation: Model 304.

Features: Actuated by the flexure of an accurately calibrated Bourdon tube, these precision instruments have a ½ watt electrical output which is linear with applied pressure. The movement of the Bourdon tube is transmitted to the wiper contact on the wire-wound resistance element by a ball bearing-supported linkage system.

Sizes: Available in 8 ranges from 0-100 psi to 0-5000 psi.

Applications: For remote measurement of hydraulic and pneumatic pressure in aircraft, guided missiles and other equipment.

Bourns Laboratories
Riverside, California
Circle 208 on Reader Service Card

For more New Product Information turn to page 88

Circle 85 on Reader Service Card

Announcing

Snap-Tite's Hi-Flow LINE

FULL SWIVEL

QUICK CONNECT and DISCONNECT COUPLERS

Long Life

ive Both Ends
Valve One End
or Plain

and Low
essure

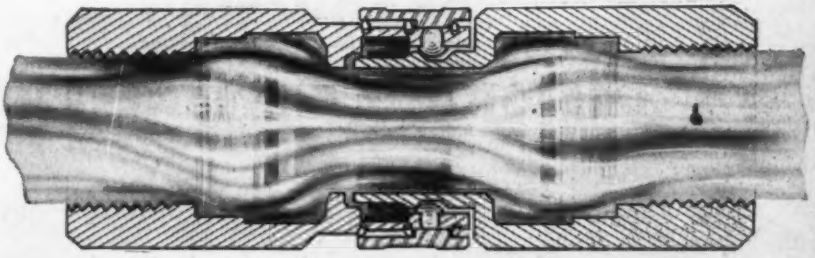
Made in Sizes 1/8" - 1/4"
3/8" - 1/2" - 3/4" - 1" - 1 1/4"
1 1/2" - 2" - 2 1/2" - 3" - 4"
6" - 8" - AND UP

For Air • Water • Oil
Gas • Chemicals
Steam, Etc.

Made from Steel
Brass • Aluminum
Stainless Steel

The Hi-Flow Line Is
Lighter in Weight

The Greatest Flow in Couplers . .



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F. R. Magill Co.
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Pittsburgh 20, Pennsylvania

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Buffalo 14, New York

Joseph Y. Fowler Co.
205 Eighth Avenue
Watervliet, New York

Charles L. Meyer
P. O. Box 279
Closter, New Jersey

Riggs Engineering Co.
P. O. Box 133
Ludlow, Kentucky

Product Maintenance Co.
3344 West 105th Street
Cleveland 11, Ohio

Cox Engineering & Sales Co.
3020 East Canfield
Detroit 7, Michigan

P. T. Standard Parts Co.
88 Douglas Street
Pontiac 16, Michigan

Walter N. Prokop
4806 West Chicago Avenue
Chicago 51, Illinois

Russell J. Smith, Inc.
1601 South Grand Boulevard
St. Louis 4, Missouri

R. V. Distributors
4122—S. E. 10th Avenue
Portland, Oregon

W. E. Layman
164 E. Exchange Street
Akron 4, Ohio

W. E. Fry & Co.
Broad at 34th Street
Kansas City 2, Missouri

Industrial Rubber Products Co.
913 Wayne Avenue
Dayton 10, Ohio

Emery Wiley & Co.
Southwestern Life Building
Dallas, Texas

Gulf States Distributing Corp.
4003 Westheimer
Houston, Texas

Ritter Engineering Co.
1515 West Liberty
Pittsburgh, Pennsylvania

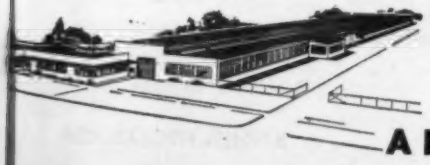
R. E. Michel Co., Inc.
1017 Greenmount Avenue
Baltimore 2, Maryland

J. N. Fauver Co.
49 West Hancock Street
Detroit 1, Michigan

L. W. Rapkin Supply Co.
3rd and Shipley
Wilmington, Delaware

Geo. A. Kushman Company
95 Market Street
Oakland 4, California

factory is devoted exclusively to manufacture of Snap-Tite quick connect-disconnect couplers.



SEND FOR NEW TECHNICAL CATALOG NO. VP 83

SNAP-TITE, INC.

ARMAND AVE., UNION CITY, PA.

Warner's Complete Facilities Include:

PRODUCTION

DESIGNING · ENGINEERING

Since 1935, Warner has specialized in the development and manufacture of precision hydraulic equipment, designed to meet the most exacting requirements.

Production of special hydraulic controls requiring close tolerances for low leakage at high pressures has resulted in the development of special lapping and manufacturing techniques.

Warner engineers will welcome an opportunity to assist you in the development of hydraulic equipment to meet your requirements.

Warner DIVISION OF DETROIT HARVESTER COMPANY OF N.Y. INC.
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DESIGNERS AND MANUFACTURERS OF PUMPS • VALVES • ACTUATORS

LITERATURE AND SERVICES OFFERED IN THIS MONTH'S ADS

For more information circle numbers on the reader service card bound in this issue.

SIMULTANEOUS DOUBLE POLE SWITCH with eigh contacts, which makes possible a wide variety of circuit combinations, saves weight and space, is described in literature available from Electro-Snap Switch & Mfg. Co.

Circle 30 on Reader Service Card

O-RINGS which stand up against high static pressures, heat friction, shock, surge, etc. are outlined in a handbook prepared by Goshen Rubber Company, Inc.

Circle 39 on Reader Service Card

QUICK COUPLERS for hydraulic lines, which connect under pressure without tools, are described by the Ulrich Mfg. Co.

Circle 100 on Reader Service Card

LIMIT SWITCHES made of rugged compact construction, have accessible wiring connections and heavy insulation throughout, are specified in engineering bulletin EM 51, published by National Acme Company.

Circle 66 on Reader Service Card

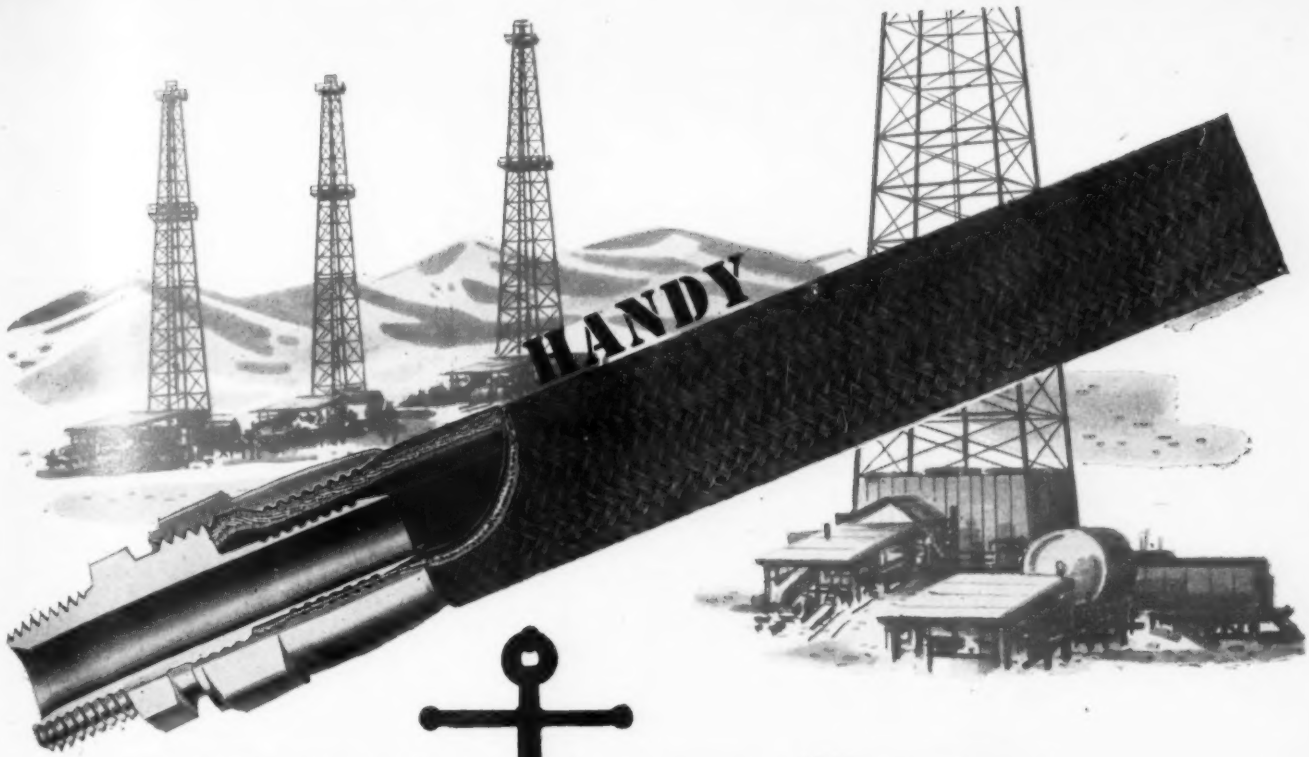
SYNCLINAL FILTERS for dependable protection of liquids in all hydraulic and low pressure systems, are detailed in engineering data offered by Marvel Engineering Co.

Circle 64 on Reader Service Card

HYDRAULIC OIL PURIFIER which removes solid abrasive contamination, prevents sludging, and keeps oil clean and safe to use indefinitely, is described in a hydraulic bulletin prepared by Honan-Crane Corporation.

Circle 46 on Reader Service Card

Continued on page 36



ANCHOR

REUSABLE COUPLING FOR TYPE QW HOSE

for original equipment and *fast field-repair* — medium- and low-pressure service

Prevents leaks and blow-offs — exclusive patented grip gives extra safety, extra dependability, long life under severe service conditions.

Expensive downtime eliminated — repairs made immediately on the job without special tools.

Easy to assemble — vise, oilcan, and wrench are the only tools needed to assemble couplings and hose.

Reduces hose assembly inventory — carry one coil in hoze sizes you use, and cut to lengths you need when you need them.

Can be used over and over.

Ample flow capacity.

NEW!
REVOLUTIONARY
ANCHOR
SPLIT-FLANGE CLAMP
Positive leakproof connection without threaded joints. Bolt centers are located to distribute the forces evenly and prevent tilting of the clamp halves. Easy to assemble with small automotive-type wrench.

Find out how Anchor reusable couplings for type QW hose save time, trouble, money. Attach coupon to your letterhead and mail today.

D-15

Anchor Coupling Co. Inc.
Dept. AH-73, Libertyville, Illinois

I'd like to know more about

- ☐ Anchor Reusable Couplings for type QW hose
- ☐ New Anchor Split-flange clamp-type coupling

Send me details.

Name.....Title.....

Company Name.....

Company Address.....

City.....(.....) State.....

ANCHOR COUPLING CO. INC.

Main Office and Factory: LIBERTYVILLE, ILLINOIS

FACTORY BRANCHES: DETROIT, MICHIGAN • DALLAS, TEXAS

FLEX-O-TUBE®

When you specify Flex-O-Tube for flexible lines you get the utmost in *dependability* as well as *bendability*.

Manufacturing facilities are keyed to precise production control. This means you can depend on Flex-O-Tube delivery dates . . . and that's mighty important when you're working against tight production schedules.

Every needed inspection and testing facility is on hand at Flex-O-Tube to safeguard the high quality standards of every product shipped. You can depend on Flex-O-Tube performance.

Dependable, too, is the engineering counsel we gladly extend when you're developing new flexible hose products. This engineering know-how is based on more than twenty years in the business.

If there's a flexible line in your product to conduct air or liquid, that has to be bendable, call in Flex-O-Tube . . . it's dependable.

3080

Supplied in Assemblies

Flex-O-Tube will help you determine the assembly needed or work to your own specifications. In either case, modern facilities and latest inspection techniques assure you a uniformly high quality product delivered promptly.

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Flex-O-Tube hose is also supplied in bulk coils with reusable fittings for field assembly. Complete range of sizes and types.

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FLEX-O-TUBE

DIVISION OF MERIDAN CORP.

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Free Literature Offered in this Month's Ads

Continued

HEAT EXCHANGERS, lightweight, rugged and compact, available in 690 standard models, are outlined in catalog issued by Young Radiator Company.

Circle 109 on Reader Service Card

MANIFOLDS for hydraulic equipment control systems, which reduce piping and result in trouble-free operation, are described in a brochure offered by Almo Tool Co.

Circle 6 on Reader Service Card

VALVES for industrial, chemical and aircraft applications are featured in a catalog offered by Republic Manufacturing Co.

Circle 79 on Reader Service Card

REGULATOR-FILTER-LUBRICATOR, all in one unit, with pressure relief feature built in, has been outlined in a catalog offered by CCA Products Division, Breco Manufacturing Co.

Circle 20 on Reader Service Card

CYLINDER FINISH STEEL TUBING for hydraulic cylinders, which eliminates boring and honing, and can be cut to length, is discussed in Bulletin R-7 published by Tube Reducing Corporation.

Circle 99 on Reader Service Card

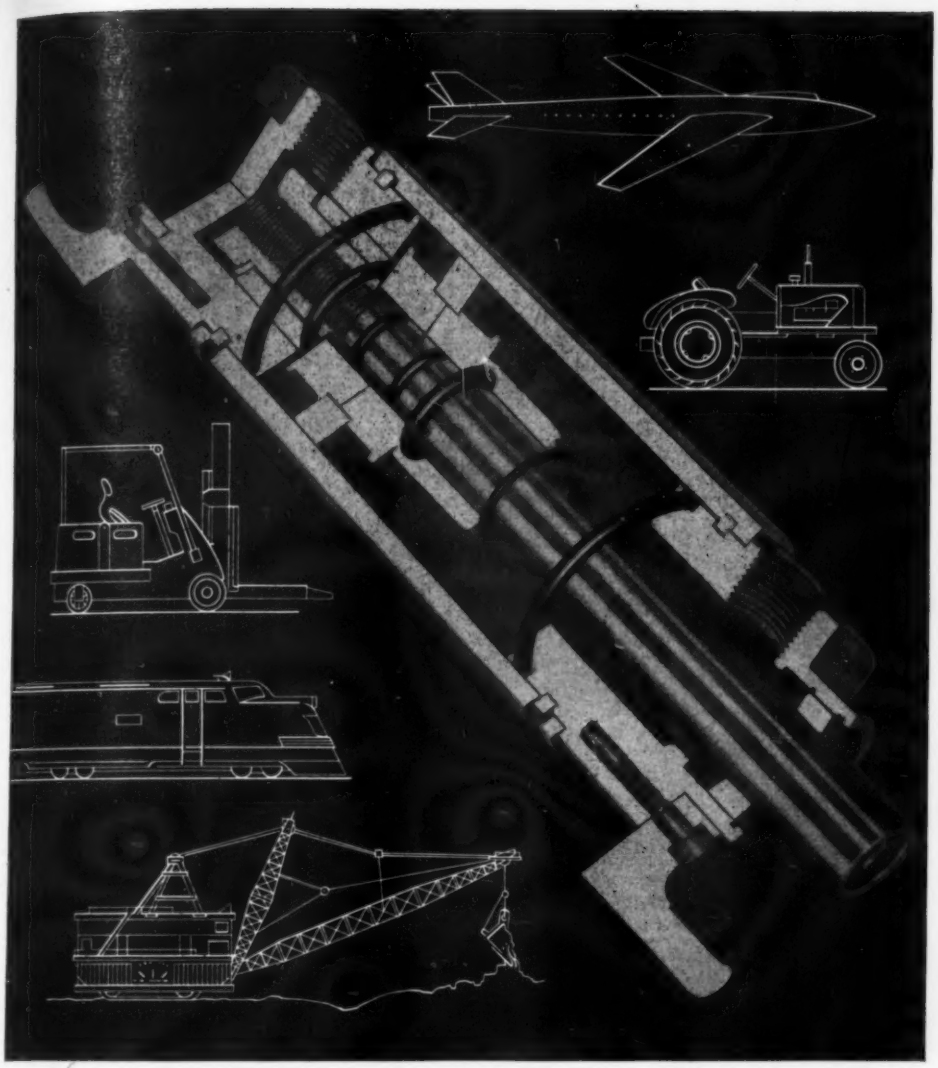
AIR CYLINDERS manufactured by the Miller Motor Company have their features and specifications described in bulletin A 105.

Circle 65 on Reader Service Card

HYDRAULIC POWER UNITS built in accordance with J.I.C. standards, and sized to meet performance requirements, are illustrated in a catalog prepared by the Cardwell Machine Co.

Circle 19 on Reader Service Card

Continued on page 38



Cutaway view of an Ortman Miller Machine Co. Standard Hydraulic Cylinder showing PARKER O-rings.

Specify PARKER O-rings for economical, leakproof seals

THIS IS IT

Cross section drawing of O-ring in groove, sealing under pressure.

For sealing in a hydraulic cylinder . . . or for whatever service you need them, you can get PARKER O-rings, molded of expertly formulated synthetic rubber compounds, that will provide long, trouble-free sealing life. That means they are economical to use. They're economical, too, because they require no complicated design . . . just a simple groove, usually saving space and weight.

PARKER makes *all* standard O-rings for fuel, hydraulic and engine oil services as well as special-service O-rings. Ask your PARKER O-ring Distributor for Catalog 5100, or write The PARKER Appliance Co., 17325 Euclid Ave., Cleveland 12, O.

Parker

TUBE FITTINGS • VALVES • O-RINGS

Plants in Cleveland • Los Angeles • Eaton, Ohio • Berea, Ky.

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Synthetic Rubber Products Co.
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Los Angeles 22, Calif.

MIAMI, Fla.
Air Associates, Inc.
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Minneapolis 5, Minn.

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Electrol Hand Pumps for Uniform 2-Way Pumping Action

The Electrol 525 Hand Pump has a volumetric capacity of 1.5 cu. in. per cycle.

The Electrol 770 Hand Pump has a volumetric capacity of of 2 cu. in. per cycle.

Electrol Double-Acting Hand Pumps are capable of delivering uniform volume, with operating pressures up to 1,500 P.S.I. They are compact in design . . . have few moving parts . . . are low in cost . . . economical in operation. They have built-in suction and pressure check valves . . . ⅜" pipe thread ports . . . and can be used in mineral oil or water. Also, there are similar units available for use in gasoline, kerosene, or equivalent aromatic fluids. Complete engineering data can be obtained on request.

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KINGSTON, NEW-YORK

CYLINDERS • SELECTOR VALVES • FOLLOW-UP VALVES
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POWERPAKS • LANDING GEAR OLEOS • SOLENOID
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Better Designed Products Use Electrol Hydraulics

Free Literature Offered in this Month's Ads

Continued

HYDRAULIC FLOW CONTROL VALVES, which automatically control load descent rates at predetermined speeds, for use on material handling equipemnt are the subject of literature available from Benton Harbor Engineering Works.

Circle 14 on Reader Service Card

RELIEF VALVES made of brass or cast iron, for pressures from 0-500 psi are detailed in mechanical data book, offered by Fulflo Specialities Co. Inc.

Circle 35 on Reader Service Card

HYDRAULIC HOSE ASSEMBLIES and their features are discussed in catalog 102 available from Eastman Manufacturing Co.

Circle 29 on Reader Service Card

PACKING DATA FILE discusses characteristics and advantages of Tannate leather packings, manufactured by J. E. Rhoads & Sons.

Circle 82 on Reader Service Card

O-RINGS for sealing in hydraulic systems, molded of formulated synthetic rubber compounds, are described in catalog 5100, offered by The Parker Appliance Co.

Circle 72 on Reader Service Card

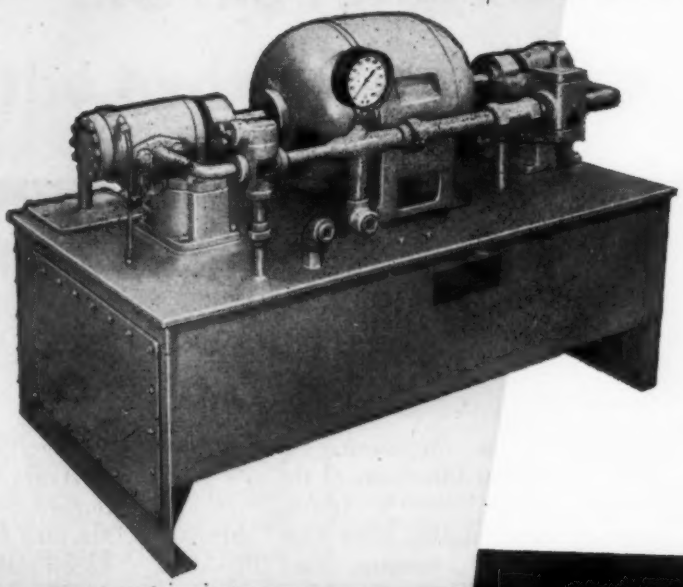
BOOST PUMPS applicable wherever low output at high pressures is required for oil or water service, are described in a bulletin issued by Sprague Engineering and Sales Corporation.

Circle 87 on Reader Service Card

PUMPS, MOTORS AND CONTROLS built for high efficiency and rugged dependability, for pressures up to 5000 psi, are detailed in literature available from Denison Engineering Co.

Circle 26 on Reader Service Card

Designed and Engineered for Specific Job Requirements



HYDRAULIC POWER

- BUILT IN ACCORDANCE WITH J.I.C. STANDARDS
- CAPACITY GEARED TO PERFORMANCE REQUIREMENTS
- SPECIAL DESIGNS AVAILABLE ON REQUEST
- TESTED AND PROVEN IN A WIDE VARIETY OF OPERATIONS

The CARDWELL MACHINE COMPANY

A CARDWELL TRADITION SINCE 1829

FRANKLIN AT 19th STREET, RICHMOND 11, VIRGINIA, U.S.A.

Write for your free copy of this catalog today!

Manufacturers of pneumatic and hydraulic components meet to form the . . .

National Fluid Power Association

THE National Fluid Power Association was formally organized on May 18 and 19 at Bedford Springs Hotel, Bedford, Pa. A group of representatives of about 45 manufacturers of fluid power components, including such products as hydraulic and pneumatic valves, cylinders and pumps set up the organization, the first national trade association of its type in the industry.

A Constitution and By-Laws were adopted, a statement of purposes and objectives accepted and officers and an Executive Committee elected. John C. Hanna, Vice President, Hanna Engineering Works, was elected Chairman of the new Association; Ben N. Ashton, President, Electrol, Inc., First Vice Chairman; John E. Erskine, Vice President, Racine Hydraulic & Machinery, Inc., Second Vice Chairman; and E. G. Peterson, President, Hannifin Corporation, Treasurer.

The nine members of the Executive Committee are John J. Pippinger, Vice President, Double A. Products Co.; E. E. Yagge, President, Gerotor May Corporation; A. F. Jensen, President, Hanna Engineering Works; O. Wendell Macy, Sales Manager, Hydraulic Power Division of Hydraulic Press Mfg. Co.; L. R. Burger, Sales Manager, Logansport Machine Co., Inc.; F. G. Kuhagen, Vice President, The Oilgear Co.; J. A. Marsh, Sales Manager, Rivett Lathe & Grinder, Inc., R. J. Murphy, Sales Manager, Hydraulic Division, Sundstrand Machine Tool Co.; and W. J. Donnelly, Works Manager, The Tomkins-Johnson Co.

Barrett Rogers, Industrial Management Consultant, was appointed Executive Secretary.

A very fine spirit was evident among the manufacturers' represen-

THE EXECUTIVE COMMITTEE of the National Fluid Power Association. Standing, left to right: R. J. Murphy, Sundstrand Machine Tool Co.; F. R. Kuhagen, The Oilgear Co.; O. Wendell Macy, Hydraulic Power Division, Hydraulic Press Manufacturing Co.; Sitting, left to right: E. G. Peterson, Hannifin Corporation; J. A. Marsh, Rivett Lathe & Grinder, Inc.; B. N. Ashton, Electrol Incorporated; A. F. Jensen, Hanna Engineering Works; John C. Hanna, Chairman, Hanna Engineering Works; J. J. Pippinger, Double A Products Co.; J. E. Erskine, Racine Hydraulics & Machinery, Inc.; L. R. Burger, Logansport Machine Co., Inc.; Barrett Rogers, Executive Secretary; and W. J. Donnelly, The Tomkins Johnson Co.

why HANNIFIN series "N" cylinders are the recognized standard of the hydraulic industry

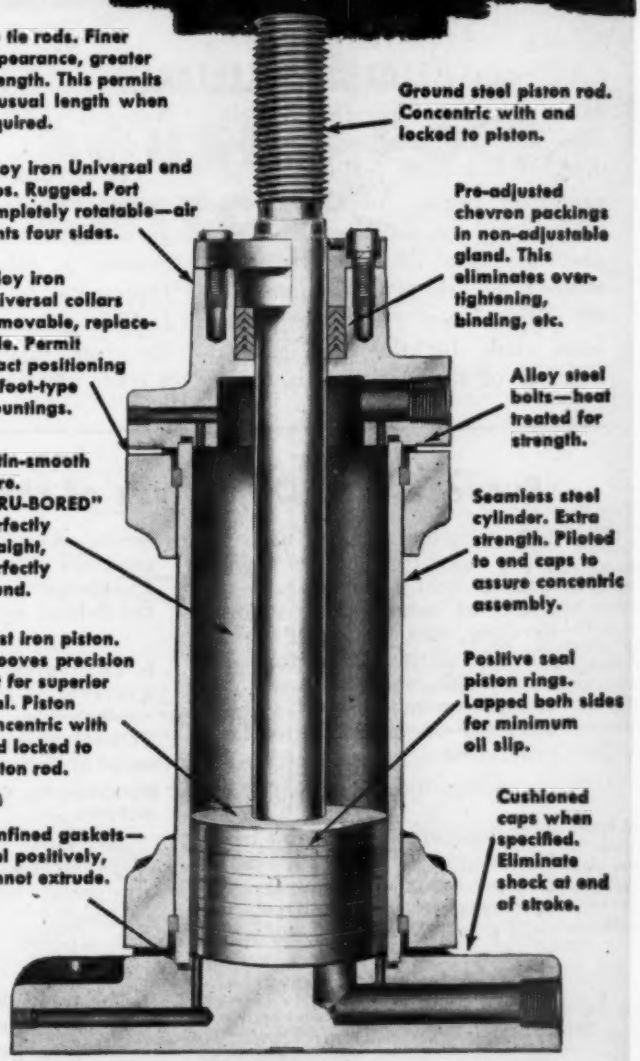
THE MOST COMPLETE STANDARD LINE

Hannifin is your single source for the broadest standard line of hydraulic cylinders on the market. When you need hydraulic cylinders, you'll save time and money by selecting from the complete Hannifin line.

- 12 bore sizes, 1" to 8"
- 11 standard mountings—more than 65 combination mountings
- No tie rods; ideal for long-stroke applications
- Cushioned and non-cushioned
- Double end piston rods available in most styles
- Bodies of heavy-walled steel tubing "TRU-BORED" and honed

WRITE FOR BULLETIN 110
Complete specifications and dimensions

DESIGNED AND BUILT FOR SUPERIOR PERFORMANCE LONGER LIFE


No tie rods. Finer appearance, greater strength. This permits unusual length when required.
Ground steel piston rod. Concentric with and locked to piston.
Alloy iron Universal end caps. Rugged. Port completely rotatable—air vents four sides.
Pre-adjusted chevron packings in non-adjustable gland. This eliminates over-tightening, binding, etc.
Alloy iron Universal collars Removable, replaceable. Permit exact positioning of foot-type mountings.
Alloy steel bolts—heat treated for strength.
Satin-smooth bore. "TRU-BORED" perfectly straight, perfectly round.
Seamless steel cylinder. Extra strength. Piloted to end caps to assure concentric assembly.
Cast iron piston. Grooves precision cut for superior seal. Piston concentric with and locked to piston rod.
Positive seal piston rings. Lapped both sides for minimum oil slip.
Confined gaskets—seal positively, cannot extrude.
Cushioned caps when specified. Eliminate shock at end of stroke.

HANNIFIN

HANNIFIN CORPORATION • 1155 S. KILBOURN AVE., CHICAGO 24, ILLINOIS

AIR AND HYDRAULIC CYLINDERS • HYDRAULIC POWER UNITS • PNEUMATIC AND HYDRAULIC PRESSES • AIR CONTROL VALVES

Circle 45 on Reader Service Card

National Fluid Power Association

Continued

A GROUP of manufacturers most of whom are charter members of the new National Fluid Power Association.

tatives, and Committees on standards, education, government relations and other activities were authorized and their preliminary organization began. Additional committees will be established at the next meeting of the Executive Committee to be held in Chicago on July 10. Preliminary plans have also been made for the next general meeting of the Association to be held in Chicago the same week as the National Conference on Industrial Hydraulics.

The establishment of the new National Fluid Power Association grew out of a meeting held on December 1, 1952, when thirty-five representative manufacturers met in Chicago to explore the needs and the scope of potential activities of a trade association in the industry. An almost unanimous agreement was reached that such an organization would be desirable and a Committee for Organization, composed of 15 members of the first group, was set up. The findings of this group, supplemented by several component group meetings held in other cities subsequently, were submitted as recommendations at the organization meeting.

Purposes and Objectives of the National Fluid Power Association

1. To engage in any activities which may further the application of fluid power to the machines of industry, the material handling, automotive, railway, aircraft, marine, agricultural, and other fields, where it can be used to conserve human effort, increase efficiency or lower the costs of production.

2. To cooperate with joint industry committees where such activities are intended to advance the performance and application of fluid power components by means of better materials, improved designs, and—where practical—standardization.

3. To encourage the organization of committees in all appropriate engineering societies for the purpose of furthering the art and science of applied fluid power.

4. To give aid and support to activities for the promotion of engineering meetings, conferences and seminars aimed at advancing the knowledge and understanding in the field of applied fluid power.

5. To represent the members, wherever it may be helpful and constructive, to agencies of the Federal government, to any segment of industry, to any user organizations, or to industry committees.

6. To undertake any practical and appropriate activity or project designed generally to further the proper use and application of fluid power components by means of educational materials.

The term "Fluid Power" refers to all systems for the transmission, application and control of hydraulic and/or pneumatic power. Any company in the United States engaged in the design, manufacture and distribution of components essential to such systems is eligible for membership in the Association.

7. To study intra-industry problems where practical and exchange know-how in matters of marketing, manufacturing, finance or engineering—leading to increased business efficiency and improved products and performance of the industry.

8. To promote and conduct intra-association activities encouraging the continued maintenance in this industry of the highest ethical standards.

9. To do anything necessary and proper for the accomplishment of any objectives herein set forth or which shall be recognized as proper and lawful objectives of trade associations, all of which shall be consistent with the public interest as well as in the interest of this industry and trade.

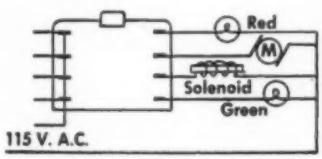
Announcing...

- **THE ONLY DOUBLE POLE SWITCH WITH EIGHT CONTACTS.** Makes possible a wide variety of circuit combinations.
- **THE ONLY DOUBLE-POLE SWITCH WITH SIMULTANEOUS "MAKE" AND "BREAK" ACTION.** Reduces arcing, prolongs switch life, increases electrical capacity and permits unusual applications.
- **THE SMALLEST DOUBLE-POLE SWITCH.** Saves weight and space; allows more compact designs.

the new ELECTRO SNAP SIMULTANEOUS DOUBLE-POLE SWITCH

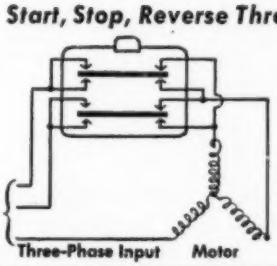
Look What You Can Do With It...

Control Four Circuits with ONE Snap



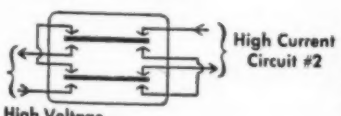
Used in motor control device at left, switch, when actuated, (1) turns off red pilot light; (2) completes circuit to motor winding, starting motor; (3) opens circuit to solenoid latch; locking door to motor gear box; and (4) turns on green pilot light.

Start, Stop, Reverse Three-Phase Motors



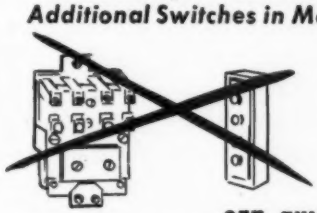
Because this new double-pole switch can simultaneously break or reverse current flow through *two* windings of a three-phase motor, you can use it as an inexpensive limit switch on three-phase lathes and drills. Use it to control automatic sequences, to limit motion of machine members driven by three-phase motors and as a start-and-stop switch.

Wire Movable Poles in Series to Switch High Current or High Voltage



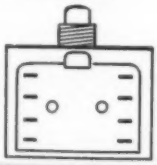
As proof of simultaneous action, you can connect the two movable poles in series to increase contact area for high current applications and to increase number of contact breaks for high voltage switching.

Eliminate Expensive Relays and Additional Switches in Many Applications



This double-pole switch offers designers a wide variety of circuit hook-ups that were formerly possible only with complicated relays or a number of separate switches. Controlling three-phase motors is but one example.

Equip with Actuator



Push-button actuator may be added for panel mounting or for long overtravel. Switch is rated at 15 amps 125/250 v. AC or 10 amps inductive, 30 v. DC. Case dimensions are only 1½" x ⅞" x ½". Weighs only 20 grams.

OTHER ELECTRO-SNAP PRECISION SWITCHES

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USEFUL LITERATURE

You'll find many valuable production and design ideas in publications described here . . . copies will be sent you free without obligation

HYDRAULIC PUMPS AND MOTORS . . . Waterbury Tool Division of Vickers Incorporated has published an engineering data catalog on a heavy duty line of hydraulic pumps, motors and transmissions. These power units provide precise control of variable volume or speed, stepless and reversible, with operating pressures up to 3000 psi, in a complete range of sizes up to 4000 hp. All units are illustrated, detailed engineering drawings shown and all specifications listed. One page of the catalog is devoted to basic hydraulic formulas which may help in the selection of units.

Circle 151 on Reader Service Card

ELECTRIC POWER DRIVES . . . Sterling Electric Motors, Inc., published a 20-page comprehensive catalog on electric power drives. The catalog contains complete descriptive information of electrical and mechanical features of variable speed drives, geared motors and constant normal speed motors in drip-proof, splash-proof, totally enclosed and pipe ventilated designs. All models featured are illustrated and sectional drawings show construction and operational details.

Circle 152 on Reader Service Card

AIR AND HYDRAULIC COMPONENTS . . . A new booklet describing the application of air and hydraulic power was issued by Rivett Lathe & Grinder, Inc. The brochure features in condensed form the complete line of valves and cylinders for any air or hydraulic circuit. There are 300 primary models in the standard line, each of which is available in a variety of types and sizes. Illustrated are some models of air and hydraulic cylinders, air valves, hydraulic valves and power units.

Circle 153 on Reader Service Card

MANUAL MOTOR CONTROLS . . . Bulletin 404 describing manual motor controls, manufactured by Federal Electric Products Company, lists special design features such as double-break silver contacts, ready servicing accessibility, and complete mounting flexibility. Available in 2, 3, or 4 poles for single phase, 3 phase, and 2 phase 4 wire systems, these manual starters come in two sizes for AC operations. Size 0, rated up to 2 hp and size 1, rated up to 7½ hp, both at 600 volts AC. Other models are obtainable for DC operations in ratings up to 1 hp (size OS) and 2 hp (size 1S), both at 230 volts DC.

Circle 154 on Reader Service Card

HYDRAULIC VALVES AND CYLINDERS . . . Galland Henning Mfg. Co., has prepared a 32-page 2-color catalog describing cylinders and valves for air or hydraulic services. Design and construction features include built-in self regulating cushion, self-sealing stuffing box packing, and quick opening ball check-valve. Four classes of construction, the standard tubing and tie rod, recessed head, standard heavy duty and series 1500 high pressure hydraulic construction are described. All cylinders are illustrated and tables of dimensions provided. Various types of valves for air, oil or water for pressures up to 250 psi and hydraulic valves for pressures up to 1500 psi are detailed.

Circle 155 on Reader Service Card

HYDRAULIC CONTROL VALVES . . . Davies Brothers has issued a catalog illustrating valves which can be used in conjunction with the Airhydropump and are available in working pressures from 750-30,000 psi. Each valve shown lists construction features and a price list is also included.

Circle 156 on Reader Service Card

HIGH PRESSURE RECIPROCATING PUMPS . . . A 20-page catalog is available from John Bean Division, Food Machinery and Chemical Corporation, describing four types of power pumps built by this company. Design, construction and application of triplex inside packed and triplex outside packed, multiplex power ends and duplex inside packed pumps are shown. One section of the catalog details pump accessories including pressure regulators, relief valves, air chambers and gages.

Circle 157 on Reader Service Card

For more Useful Literature reviews turn to page 100

Circle 29 on Reader Service Card

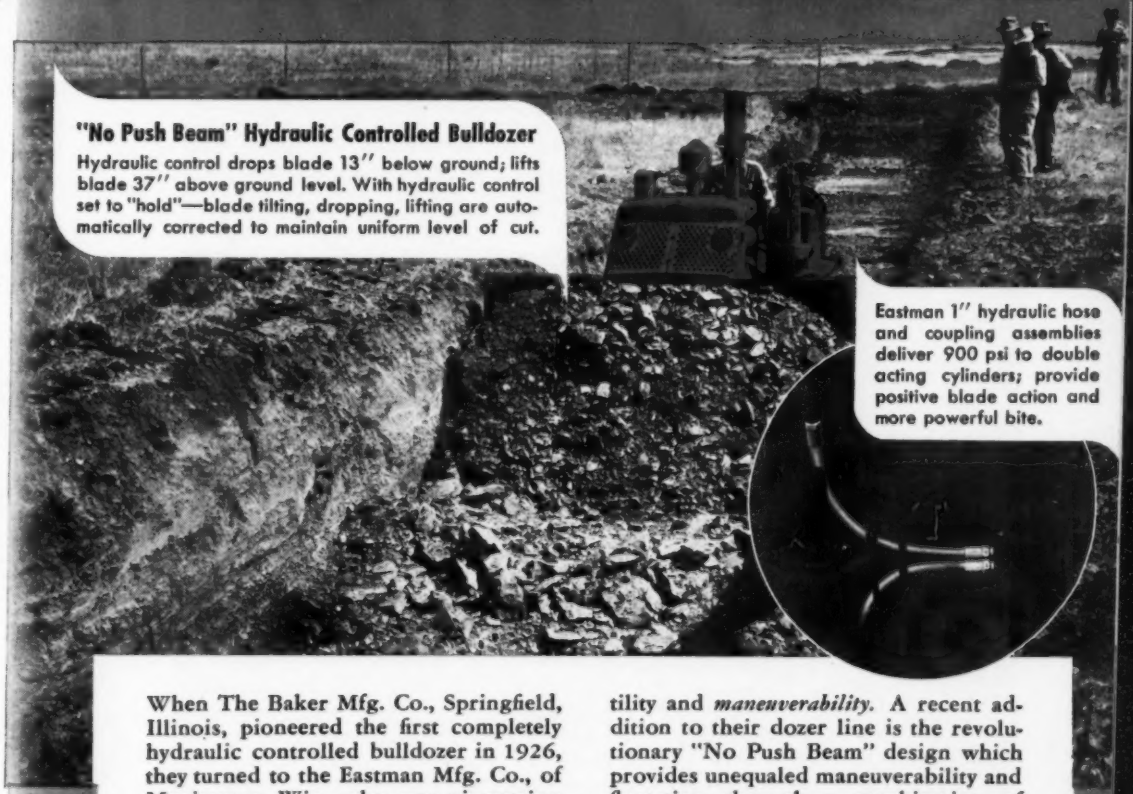
SAFEGUARDING INDUSTRY'S *Lifelines of Mobile Power*

Two Pioneers at Work

...27 YEARS AGO...and TODAY!

BAKER *pioneered* **THE HYDRAULIC CONTROLLED BULLDOZER**

Eastman *pioneered* **HYDRAULIC HOSE ASSEMBLIES**



"No Push Beam" Hydraulic Controlled Bulldozer

Hydraulic control drops blade 13" below ground; lifts blade 37" above ground level. With hydraulic control set to "hold"—blade tilting, dropping, lifting are automatically corrected to maintain uniform level of cut.

Eastman 1" hydraulic hose and coupling assemblies deliver 900 psi to double acting cylinders; provide positive blade action and more powerful bite.

When The Baker Mfg. Co., Springfield, Illinois, pioneered the first completely hydraulic controlled bulldozer in 1926, they turned to the Eastman Mfg. Co., of Manitowoc, Wis., who was pioneering in the field of hydraulic hose assemblies *at the same time!*

Then, as now—all through these years—Baker bulldozers have been equipped with Eastman Hydraulic Hose Assemblies *exclusively,* giving service in accord with the high standards that have made both Baker and Eastman leaders in their respective fields.

The enviable reputation of Baker "Dozers" is based upon their advanced engineering, plus their durability, versatility and *maneuverability.* A recent addition to their dozer line is the revolutionary "No Push Beam" design which provides unequaled maneuverability and floatation through a combination of unique mechanical linkage and hydraulic suspension.

Positive, dependable power is delivered to these controls through Eastman wire braided hydraulic hose, ranging from ¾" to 2" . . . carrying pressures up to 900 lbs. psi. Leakproof hydraulic couplings form the vital connecting links . . . another example of Eastman's leading role in *"Safeguarding Industry's Lifelines of Mobile Power."* Look to Eastman for leadership in this field.

specify **Eastman** *first in the field*

HYDRAULIC HOSE ASSEMBLIES

for the best performance, for long life and satisfaction—*all along the line*—from manufacturer to user. Check your needs on the following list:

COUPLINGS

Solid Male

Swivel Male

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STRAIGHT AND ANGLED ADAPTER UNIONS

Straight Male

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Write for free catalog 102 on Eastman Hose Couplings and Bulletins 231B & 232B on Straight and Angled Adapter Unions.

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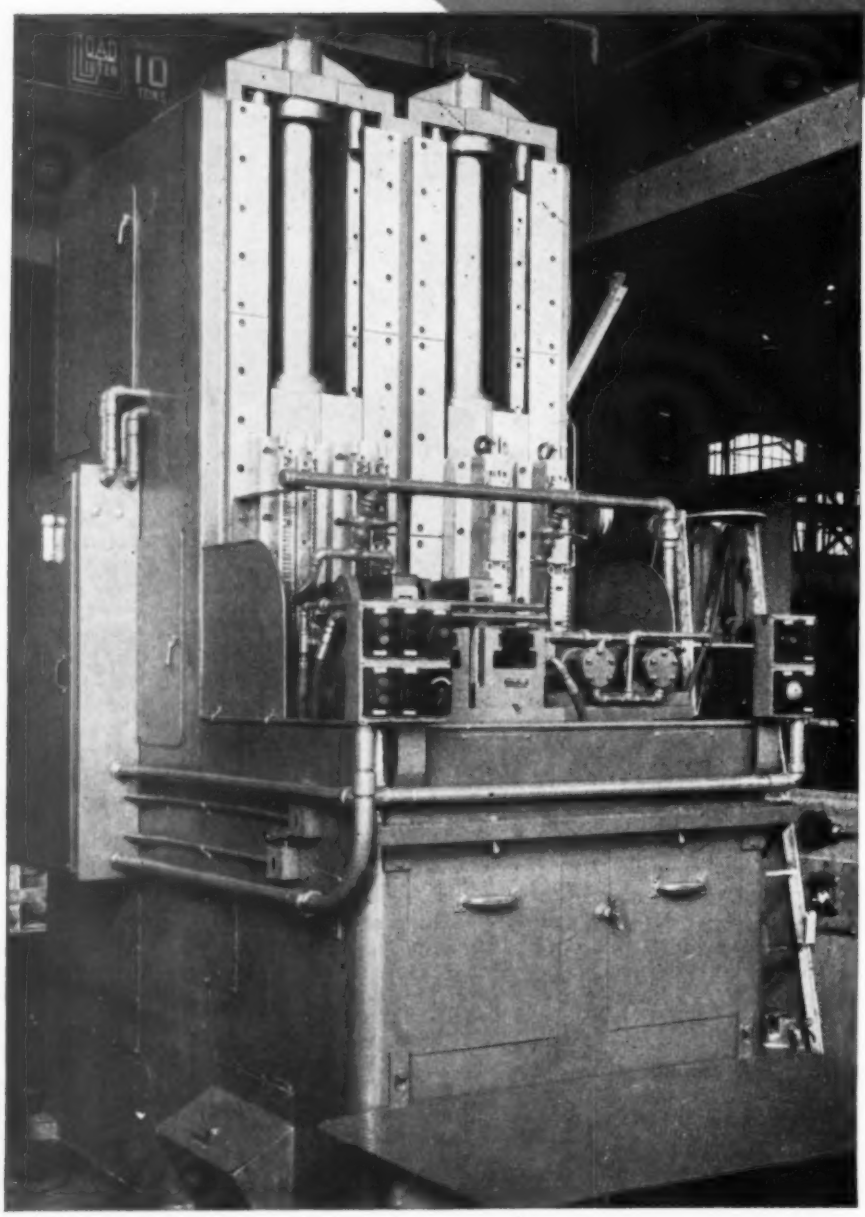
WHY AMERICAN BROACH USES TEXACO



THE American Broach & Machine Company of Ann Arbor, Michigan, a division of Sundstrand Machine Tool Company, uses hydraulic machine tools to make its own famous line of hydraulic broaching machines and broaching tools. And in these hydraulic machine tools, the hydraulic medium is *Texaco Regal Oil (R&O).*

Why does American Broach use Texaco? Because *Texaco Regal Oil (R&O)* gives them these benefits—

— freedom from rust, sludge and foam
— smooth, trouble-free operation
— longer pump and parts life
— lower maintenance costs

Texaco Regal Oil (R&O) is turbine-quality oil *improved* by special additives and processing. Tested against ordinary turbine-quality oils, it shows *more than ten times greater oxidation resistance* and far superior rust- and foam-preventing ability.

There is a complete line of *Texaco Regal Oils (R&O)* approved by leading hydraulic manufacturers. Let a Texaco Lubrication Engineer help you select the one best for your equipment and operating conditions. Just call the nearest of the more than 2,000 Texaco Distributing Plants in the 48 States, or write:

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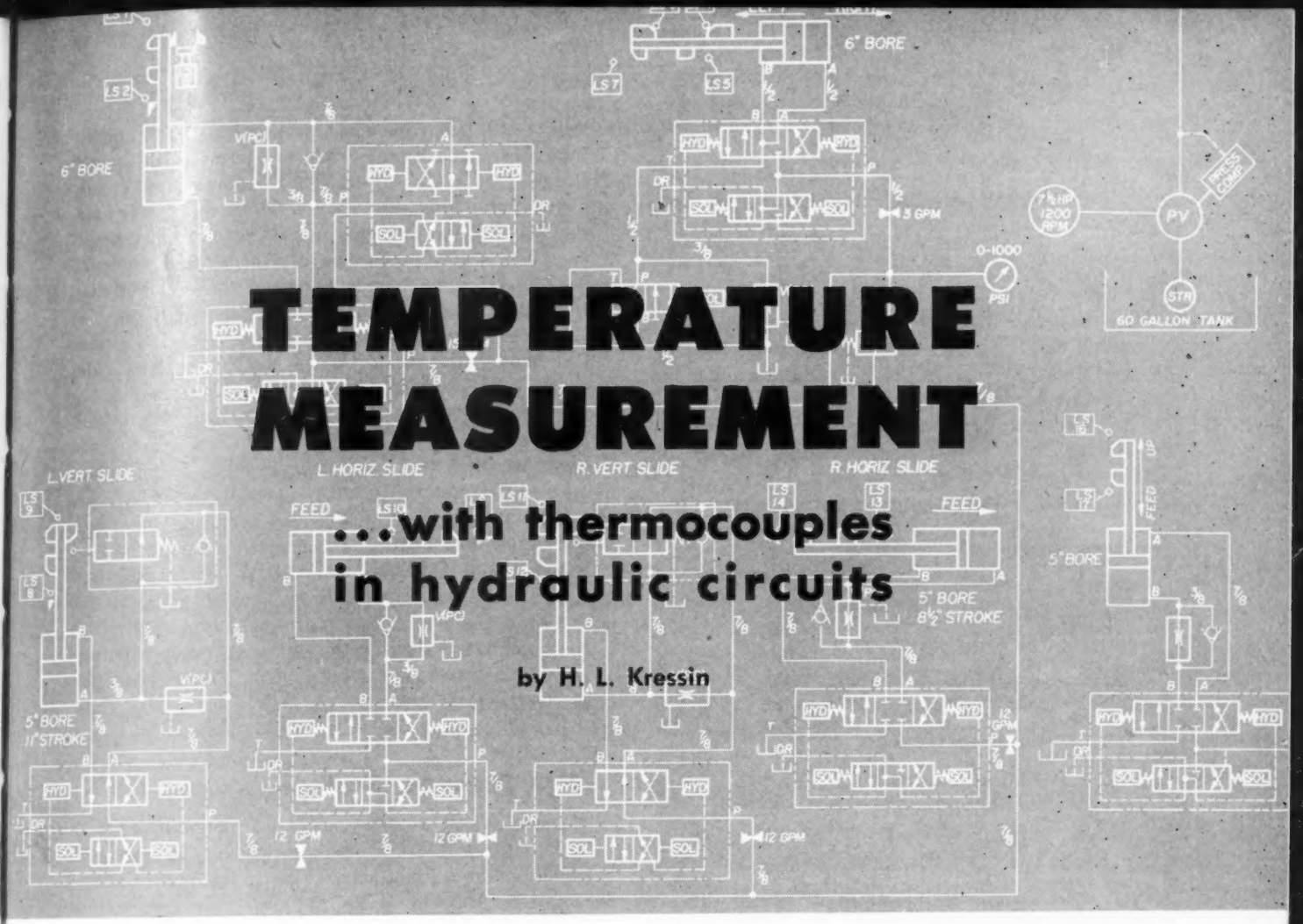
FOR ALL HYDRAULIC UNITS



TEMPERATURE MEASUREMENT

...with thermocouples in hydraulic circuits

by H. L. Kressin

Design and operation of thermoelectric thermometers —thermocouples—and temperature recording devices.

WHEN making dynamic and static measurement of temperature, vibration, noise, speed, and flow, a non-complex form of electrical circuit can be used. The measurement of these parameters is accomplished by the principles incorporated in the measuring transducer. Since these transducers are simple in principle, it can be said that their associated circuits and indicating devices may in principle also be unelaborate. The form of transducers used for the parameters mentioned above are normally self-excited; that is, they need no external AC or DC voltage to excite them. The outputs of these transducers are solely dependent on the parameter being measured; therefore, they lend themselves to simple, accurate, and lasting calibration.

The least complex type of self-excited transducer is the thermocouple. The thermoelectric thermometer or thermocouple, as it is called, is valuable on account of its sensitivity, quick response to temperature changes, and the small size and mass of the part which must be heated. The thermocouple is simply a contact between two dissimilar pure metals. For low-temperature measurements the most commonly used combinations are

This is the second article in a series describing instrumentation techniques applied to the development of hydraulic circuits. Mr. Kressin's first article, "Electronic Instrumentation", April, APPLIED HYDRAULICS described devices for measuring pressure, strain, force, and motion. Future articles will discuss flow and vibration measurements and control devices.

H. L. KRESSIN, The Franklin Institute of the State of Pennsylvania, Philadelphia, Pennsylvania.

. . . a contact between two dissimilar pure metals, provides quick response to temperature changes

iron and constantan or copper and constantan.

When the two wires of a thermocouple are placed in contact there is a flow of electrons from one metal to the other. We know how to measure current, and current by definition is the rate of flow of electrons. The rate at which these electrons flow, however, depends on the difference in temperature between the hottest and the coldest points in the measuring circuit. This difference in temperature is normally established

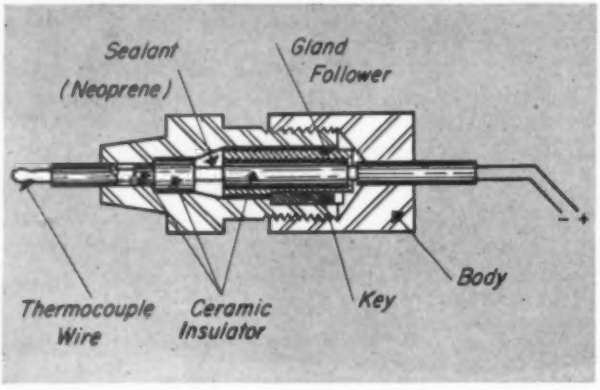


FIG. 1. Cross-section of thermocouple gland. Using a Neoprene seal makes it possible to seal test pressures as high as 15000 psi.

Courtesy Conax Corp.

by what we call a "hot junction" and a "cold junction." The cold junction in our system of measurement is either 0°C or 32°F.

Construction of Thermocouple Junction

Before taking up the electrical circuit, and the types of recorders most commonly used in temperature measurements, we should consider the design and construction of a thermocouple junction. If the two metals that form the couple are hammered to tissue-paper thinness, the couple will respond very quickly to temperature changes. In fact, if the wires are hammered thin enough, they can be used as a speech pickup. It is easy to see that so fragile a couple is not often practical. In practice we need a couple which can withstand more abuse. Thermocouple junctions are normally formed by using any practical method that will insure a perfect or well bonded contact. This can be done by twisting the two wires together, and then soldering or welding the joint. A good welded joint is easy to make, and will have the longest trouble-free life.

In a great many uses, the thermocouple junction must be protected against corrosion, or it must be shielded to prevent it from contaminating the solution into which it is placed. These problems are normally solved by using thermo-walls or thermo-shields which will give the needed protection. But now instead of having a small highly sensitive couple, we will have a junction-and-shield assembly which is enormous by comparison, and whose response to a temperature change may be a hundred or even a thousand times slower than that of the junction alone. Usually the chief cause of slow temperature-response is simply poor heat transfer through the shield. When shields are heavy and structurally complex, their surface-volume ratios (or "surface coefficient") are inevitably low. This magnitude of the surface coefficient is also dependent on the fluid in which the thermocouple shield is immersed, and on the material used to make the shield. A few good materials that conduct heat very well are monel, aluminum, and copper. When a couple must be used within a well, the entire assembly should be calibrated to determine the response time. The calibrating device can consist simply of two controlled baths, with means for quickly transferring the well and couple from one bath to the other, and recording the time required for the temperature change.

High Pressure Seal

Occasionally, we must measure temperature changes of a part in a vessel or chamber which is at a pressure higher or lower than the atmosphere. Here, the thermocouple assembly must be oil-tight. If the temperature gradient between the internal and external atmospheres is small, the thermocouple assembly can be sealed off with a plate of some sort in which are set two terminals—usually of brass or steel. These terminals protrude, of course, from both sides of the plate. However, if the temperature gradient is large, these terminals will also act as thermocouples in their own right and produce inaccuracies in the measurement. Therefore, some arrangement, as shown in Figure 1, must be used which will seal the thermocouple assembly against pressure and allow the bare thermocouple wires to pass out of the assembly unbroken. Packing glands are available to seal thermocouple wires against pressures greater than 4000 psi.

We've stated that a thermocouple is basically the joint between two dissimilar, pure metals. The most-used combinations of metals, and the ranges of temperature within which they have a straight-line calibration, are the following:

Thermocouple		Range
Copper-Constantan	CC	–200 to 500°F
Iron-Constantan	IC	0 to 1200°F
Chromel-Alumel	MA	0 to 1400°F
Platinum-Rhodium		0 to 3100°F

The simplest instrument for measuring thermocouple voltages is the portable, manually operated, galvan-

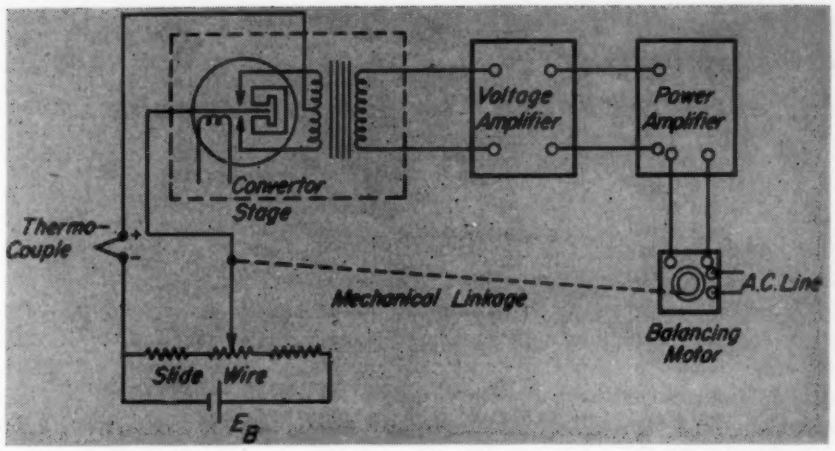


FIG 2. Schematic of an automatic recording device to measure and record both constant and rapidly changing temperatures.

ometer-type millivoltmeter. Generally this instrument is built around a highly sensitive galvanometer, and a long-scale balancing circuit. A simple, manually operated balancing circuit is built into the instrument. This balancing circuit not only corrects for the inaccuracy which may arise in the instrument, but it eliminates the need for the cold junction of ice water, which is quite troublesome to carry around. Since this instrument is manually operated, it requires constant or periodic attention by the person carrying on the test. Moreover, the conversion table supplied by the manufacturer for converting the millivolt reading obtained to a temperature reading are usually troublesome.

To overcome these difficulties, automatic recording devices are marketed to measure and record both constant and rapidly changing temperatures. Fundamentally they consist of a null-balance arrangement, which is adaptable to the measurement of practically any DC signal, e.g. those produced by pressure and force transducers. These recorders, Figure 2, consist of: (1) a measuring circuit, (2) a converter, (3) an amplifier, and (4) a balancing motor. In these recorders the amplifier is an AC amplifier, instead of a troublesome DC amplifier. For this system the emf from a thermocouple is changed into an AC signal by the action of a vibrating reed converter. The output of this converter is directly related to the line voltage, or the voltage of a standard cell. This enables the system to recognize on its measuring circuit slidewire an increase or decrease in the pickup voltage from a previously balanced condition.

At the present time there are available two types of indicating and recording potentiometers: the direct-reading type, and the strip-chart recording type. The direct-reading type is designed to measure or indicate

Iron-Constantan thermocouples gave important temperature data during the test of this hydraulic power drive. The couple wires were inserted into a .080 brass tube with the couple end open. The tube was then forced into a 1/8 inch diameter drilled hole until contact was made with the valve block in the drive housing.

Valve face temperatures were measured at three points. During the run-in phase of the test program, a rapid rise in temperature of the outside sealing surface was indicated early enough to permit shut down of the drive before costly damage took place. This temperature measurement also indicated a trouble source which was readily corrected.

Temperature measurements were made at points where starvation might occur and cause excessive wear. An immediate temperature rise would give warning of this condition.

. . . with a grounded thermocouple and long extension leads, stray voltage and excessive voltage drop can affect accuracy of temperature measurement

just one temperature at a time. However, when necessary, any number of temperature readings can be obtained by feeding the thermocouples into a manually operated switching unit, Figure 3. These indicating instruments are especially suited for measurement of temperatures that have a small variation over a significant period of time. Their long circular scale makes

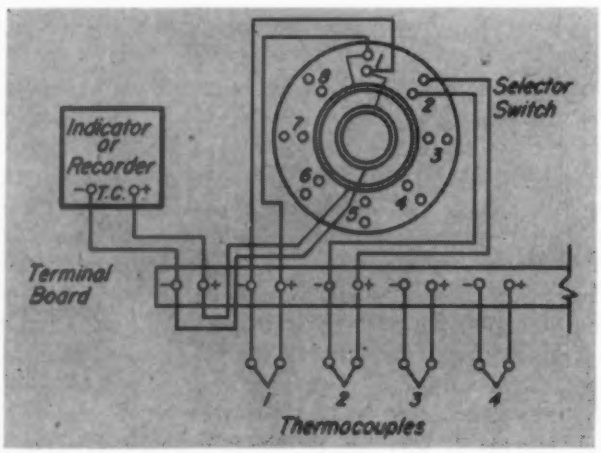


FIG. 3. Different temperature readings may be obtained by using a selector switch to connect the indicator with any one of the thermocouples connected to the switch.

their readings accurate and easy to read.

The strip-chart recording potentiometer is designed to make a continuous recording of the temperature or group of temperatures being measured. The simplest of these units is the single-point, curve-drawing recorder. A two-point, curve-drawing instrument is also available which will record related temperatures from a pair of couples. It indicates the two temperatures alternately, and for comparison, records them side by side.

Use of Strip-Chart Recorder

The most elaborate temperature indicator is the multi-point, curve-printing, strip-chart recorder. This unit prints on a moving chart the number of and a dot for the thermocouple being checked. While the temperature is being printed on the chart, a pointer also indicates the temperature on a well defined scale.

All of these instruments are normally quite versatile. At a small cost, their manufacturers will supply a kit which will change the range of the instrument. Therefore, one basic instrument can be easily converted to accomodate many ranges and types of couples.

A two-point recorder has now been designed and built to record two independent variables on a common chart. This instrument facilitates analyses involving comparative measurements between temperature, pressure, speed, flow, etc. It also does away with tedious, time consuming, and often cross-reference comparison between individual slow-speed phenomena.

Basic Electrical Circuit

The basic thermocouple circuit is simply the couple and its lead in wires. For normal measurements it is not necessary to avoid grounding the couple at the point of junction. It may be necessary to use long extension leads. However, with both a grounded couple and long extension leads of comparatively high resistance, two conditions arise, which affect the instrument operation and accuracy. These are stray voltage (60 cycle pickup) and an excessive voltage drop between couple and instrument. Stray voltages can be removed by shielding the thermocouple leads, and by placing a condenser between the positive side of the instrument and ground, Figure 4. This condenser will pass to ground only the harmful stray AC voltage. The effects of the voltage drop in long lead wires can only be reduced by using relatively heavy thermocouple lead wire, or by placing the cold junction near the couple and then using low-resistance copper wire to the instrument. For all cases it's considered desirable to calibrate the couple, lead wire, and instrument as a unit. For wire lengths up to 25 feet the voltage drop is small, but when lengths from 50 to 75 feet are used,

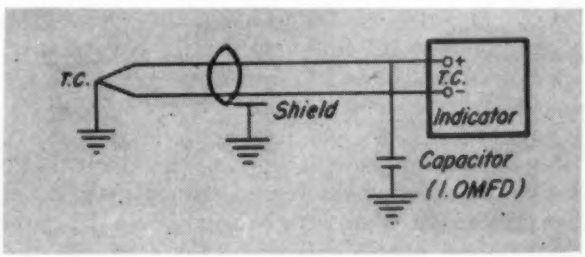


FIG. 4. Shielding protects the thermocouple from stray voltage (60 cycle pickup). The condenser will pass to ground only the harmful stray AC voltage.

the voltage drop becomes appreciable and must be corrected.

The thermocouple and its associated electronic indicating device, is a highly valuable tool for simple or complex measurement of temperature. The thermocouple can be applied to points in a hydraulic system, which are normally inaccessible with a thermometer. The accuracies involved may not be as good as those obtainable with a thermometer, but normally it is well within practical limits.

HYDRAULIC LEVER Clamps Press Die

By
E. W. Friedl

A SIMPLE hydraulic lever can do a lot of work. We applied the principle to get a 6000 pound clamping force on a press die. The job required that clamping pressure be applied from the bottom of the bed on a 50 ton mechanical press. Clamping had to be initiated automatically with the press stroke and the pressure had to be maintained while horizontal upsetting punches were cam operated by the press downstroke to complete the work.

Figure 1 shows the closed circuit which was worked out to do the clamping. The clamp cylinder, a cross-section is shown in Figure 3, requires only 1/16 inch stroke. Having a diameter of 2¼ inches, the clamp cylinder requires approximately ¼ cu in of oil for each stroke. An oil pressure of about 1510 psi must be developed to obtain the 6000 psi clamping force. This required oil, volume and pressure are obtained from the pump cylinder shown in Figure 2.

Stroking of the pump is accomplished by a cam turning with the press crankshaft and bearing against the roller on the end of the pump piston. With a pump piston diameter of 1⅛ inches, a pump stroke of ¼ inch is necessary to supply the required oil. Design of the flywheel mounted cam is very critical. It must assure full clamping pressure before and during the entire working stroke of the upsetting punches.

A small, 64 cubic inch air-over-oil bottle is in the circuit to supply makeup of any oil lost as leakage.

To hold clamping pressure during the work stroke, and to protect the clamping cylinder from overload caused by stock thickness variation or double loading of the die, a spring loaded accumulator is built into the pump cylinder. This accumulator has a ⅞ inch diameter piston backed up by a heavy spring which is preloaded to about 908 pounds. With this spring loading the accumulator piston does not move until the clamp pressure exceeds 1510 psi. Pressure greater than this value will cause the accumulator piston to move back and when pressure reaches 2135 psi the piston will have uncovered a relief valve port to dump the high pressure oil back to the air-oil bottle. The drawings clearly show the details of the protective device.

Because trapped air would make the clamp ineffective, air bleeds in the clamp cylinder and pump

E. W. FRIEDL, Design Engineer, Precision Products, Inc., Cleveland, Ohio

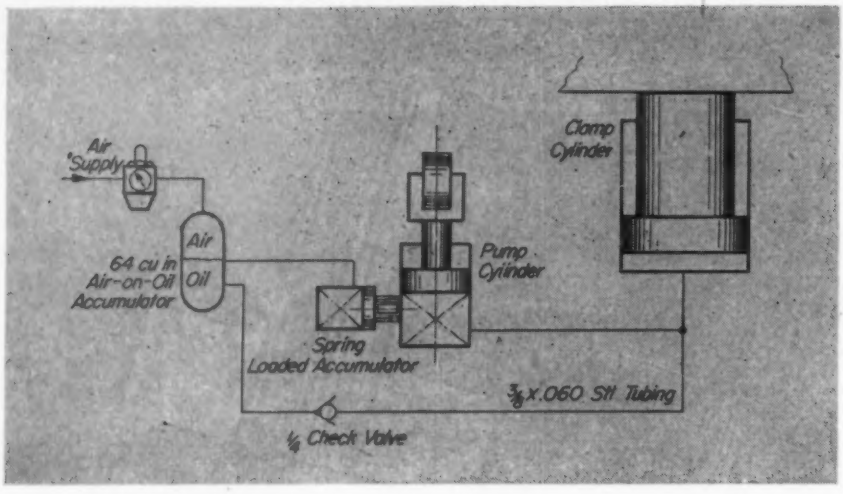


FIG. 1. CIRCUIT for the press clamp. The pump is operated by a cam on the press crankshaft.

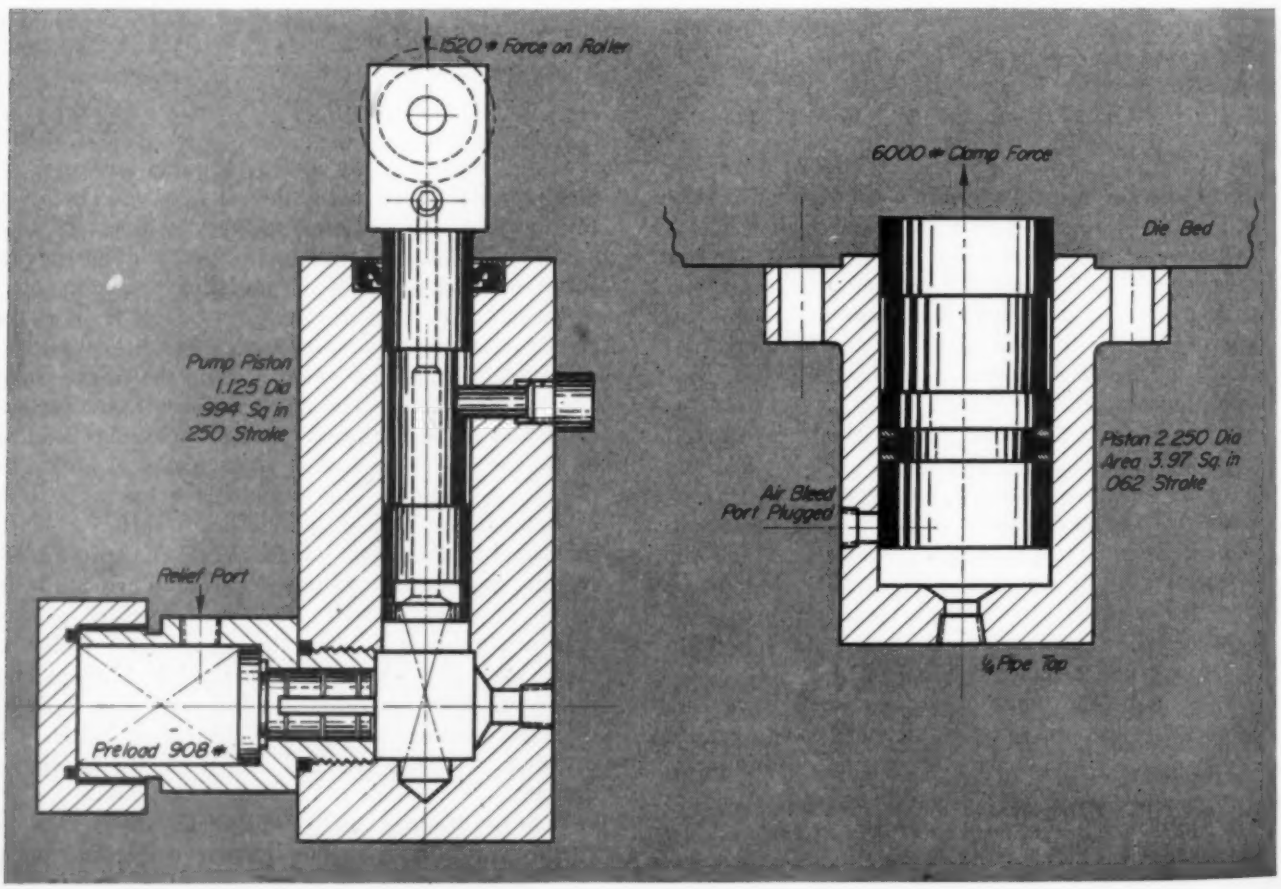
are provided. With the bleed port plugs loosened, the mechanism can be cycled several times to remove air from the system.

The system is entirely self contained, only requiring the air connection to the replenishing bottle. Machined from mechanite and steel, the rugged pump and clamp cylinders are rigidly mounted to the press frame. Oil flow is through 3/8 x .060 seamless steel tubing. Simple "O" ring packing with backup rings are used on both the clamp and pump pistons. Removal of the pistons for packing service is easily done.

While the circuit is rather unique for the application, its design follows very basic fundamentals of a hydraulic lever. All sizes are readily computed by using Pascal's Law about pressures in a static enclosed system being equal throughout the system and by applying the fundamental force = pressure x area relationship.

FIG. 2. PUMP CYLINDER has a built in spring loaded accumulator to maintain pressure during clamping and protect the system from overload.

FIG. 3. CLAMP CYLINDER has only 1/16 inch working stroke. A clamping force of 6000 psi is developed. An "O" ring seal with back up rings is used on the piston.



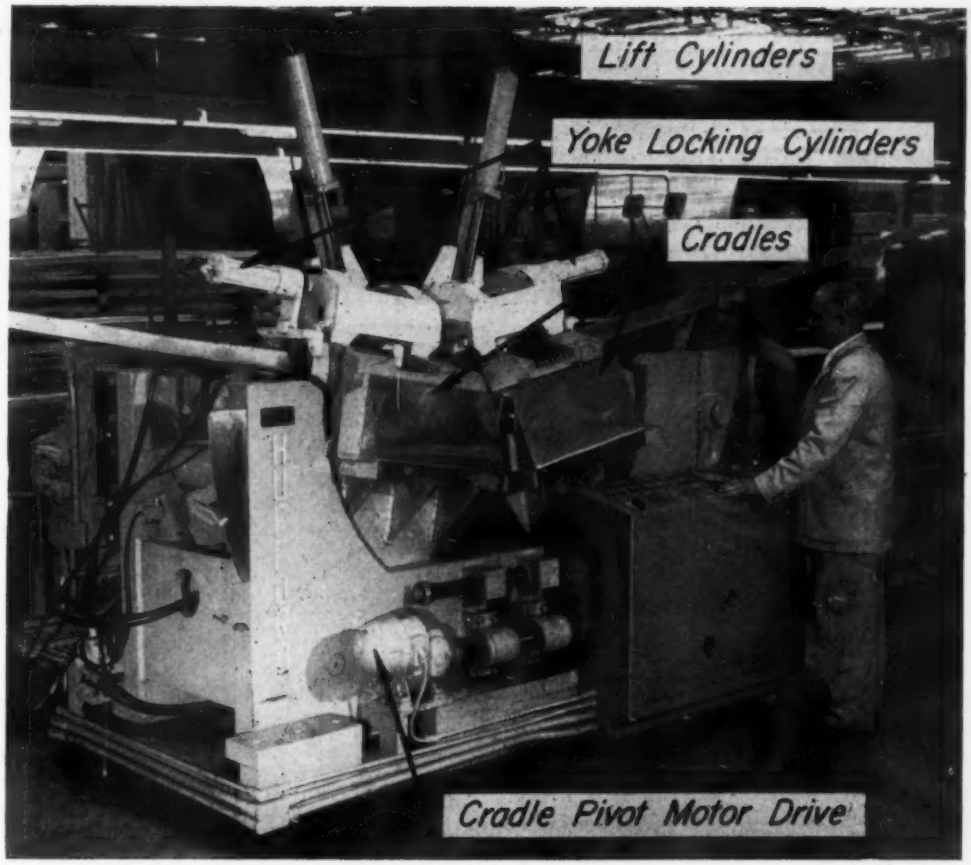


FIG. 1. All bending and clamping motions on this beam bending machine are powered hydraulically. Two cradles accomplish bending by rotating upwards simultaneously.

SERVO CONTROL VALVE Equalizes Bending Action

On this new production machine, developed for bending aircraft frame members, several hydraulic circuit problems which are common to many oil powered machines have been solved. One is the ever troublesome problem of synchronizing cylinder motions. Another is pressure regulation. Hydraulic circuits have been combined with ingenious mechanical design to give a very versatile beam bending machine which is doing a great range of bending jobs with greater efficiency and economy.

AIRCRAFT designs using new high strength aluminum alloys for beam caps and other extrusions, which require dihedral and sweep back angles, have introduced a different production problem. Before the manufacturing research branch at Lockheed Aircraft Corporation tackled the project of developing a practical bending method, bend blocks and dies were used to bend beam members. The advent of 75 ST aluminum alloy required hot bending, making previous methods impractical.

A new hydraulic beam bender, shown in Figure 1, was designed to meet this difficult production trouble spot. Used primarily for bending wing beams, but capable of handling other type beams, the machine can bend a 5 inch x 3½ inch 75 ST aluminum alloy beam up to 50 degrees at 325 degrees Fahrenheit. Built by Hufford Machine Works Inc., the machine has five hydraulically powered motions using 12 cylinders that take oil pressure from a two stage vane pump delivering 13.4 gpm at 2000 psi.

Jobs which formerly required 30 minutes are now done in 3 minutes. Greater accuracy in bending has been realized on this machine which requires no spe-

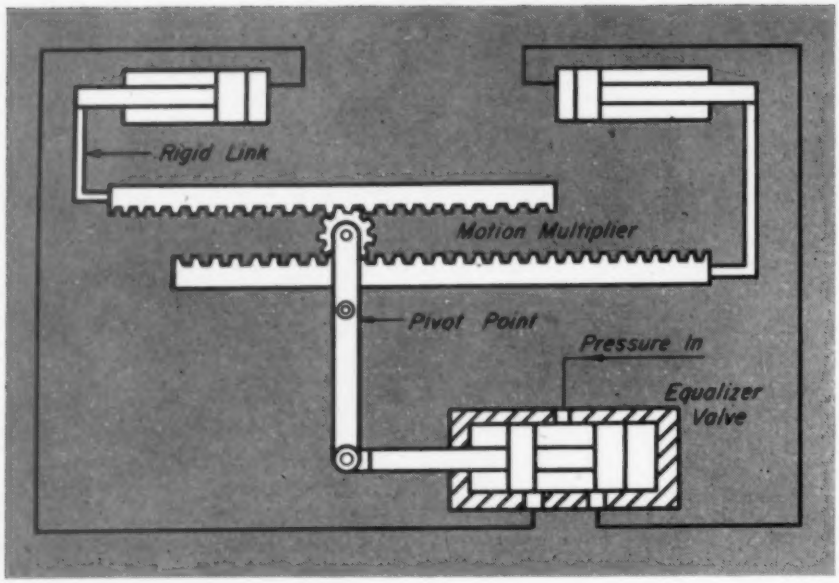


Fig. 2. Servo circuit synchronizes movement of the bending cylinders. The rack and pinion linkage multiplies any error in movement between the cylinders. The valve spool movement responds to any error and directs oil to correct the error.

cial operating skill and no special "developed" tooling.

Bending Method

Design of the tooling provides for complete control over the bending process, including the forming angle, temperature of the work, temperature of the bending dies and springback.

With the part placed in the machine, the upper clamping yokes are lowered and locked hydraulically to inner retaining shoes. The work is gripped by jaw inserts which are machined to conform to the work cross section. These inserts are in split pairs and clamp the work piece by means of a wedge which is hydraulically powered by clamp cylinders. Space for integral heater elements is provided above and below the jaw grippers.

The two main cradles then lift simultaneously to bend each leg of the beam to the required angle. Both cradles are capable of rotation, as shown in Figure 3, permitting twisting or detwisting of the work. Twist may be produced in opposite directions by each cradle. The bend angle, which can be held to an accuracy of ten minutes, is preset on a calibrated scale. When the angle setting is reached, a limit switch is tripped stopping the movement of the bending cylinders. At the end of each bending phase of the cycle, the bending mechanism locks and is held for a given dwell until released by pushbutton. Upon release, the machine forces are neutralized and the part springs back to its true bend which is accurately indicated on the scale while the part is still gripped in the machine. During the rotational phase, twisting occurs while the pushbuttons are depressed. When pushbuttons are released twisting forces are neutralized allowing the part to spring back to its true angle of twist. Bending and rotational forces can both be applied, forward or reverse, allowing easy correction for over or underbending.

Neglecting friction, there is available a theoretical bending moment of 1,980,000 inch pounds, and a twisting moment of 820,000 inch pounds.

Two hydraulic cylinders power the cradles to bend the work. At 2000 psi, each cylinder develops 28.27 tons and can bend the part through 25 degrees in 18 seconds. Figure 2 shows the equalizing valve circuit which was developed by Hufford to move the two identical bending cylinders simultaneously.

At an early stage in the design of the beam bending machine, it was decided to use two main cylinders to perform the bending operation instead of one. By the use of two cylinders, it is not necessary to dig a pit which would have been necessary with the use of the one cylinder design. However, the two cylinder operation introduced the problem of simultaneous movement.

Synchronizing the Bending Cylinders

Basically, the beam bending machine consists of two frames, called quadrants, which are rigidly connected during a forming operation. A cradle is housed in each quadrant. The cradles, constrained by circular keyways machined in the quadrants, pivot about imaginary centers when actuated by the two main bending cylinders. Additional equipment housed in each cradle, including the tooling, effectively clamps the spar or beam to each cradle preparatory to bending. The bending operation is accomplished by pumping hydraulic oil under pressure into the main bending cylinders. These in turn actuate the cradles about their pivot points creating a bending moment in the spar which is clamped to each cradle. An electric drive motor is used to change the pivot point separation from 5 inches minimum to 14 inches maximum allowing for bend radii exceeding all known requirements.

It was found that if the cradles were not actuated simultaneously, an undesirable joggling effect was produced in the spar, as well as, eccentric loads with accompanying high stresses, on the machine. Because of frictional differences between the two main cylinders and, also, between the cradles sliding in the circular

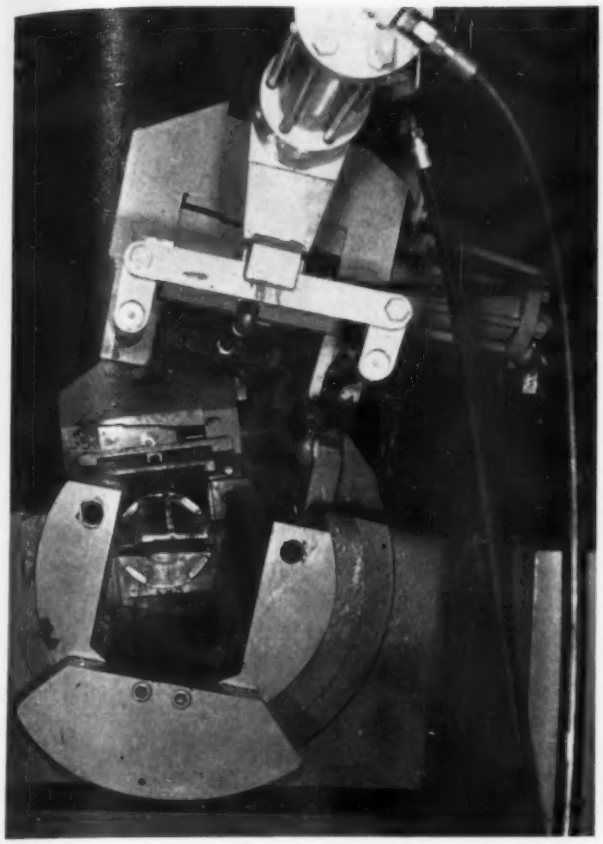


FIG. 3. Rotational movement of the cradles produces or corrects a twist in the work part. Each cradle rotates independently up to 8 degrees each side of center. In the photo, the rear yoke is shown in clamping position. Front yoke is raised with grippers removed. Yoke locking cylinder is in foreground. Workpiece clamp cylinder is at the side.

keyways, it was impossible to obtain the desired accuracy of movement without a controlling device.

The controlling device consists of the equalizing valve, connected through a linkage, to the cradles. The rack and pinion linkage serves the purpose of amplifying the disparity of movement of the cradles to the equalizing valve.

The heart of the servo control is the equalizing valve. This valve is a simple, spool type, three-way valve. Each of the two outlet ports is connected to a main cylinder. In the neutral position of the spool the lands cover all but a very small portion of the outlet ports. The pressure port remains uncovered at all times. During a bending operation, if one cradle starts to move slower than the other, this movement is transmitted through the linkage to the equalizing valve causing the spool to shift in the direction which will uncover the port of the slower moving cylinder and cover the port to the faster moving cylinder. Since the volume increases to the slower cylinder and decreases to the faster cylinder, the slower cylinder speeds up and the faster cylinder slows down. As this action takes place, the linkage transmits movement to the equalizing valve gradually shifting the spool until, as the speeds are equalized, the spool will again be centered, allowing equal volume to flow to each main cylinder.

Servo Control System

Power is developed by a 2000 psi pump. This pump is a two stage design having two identical vane rotors, each capable of developing 1000 psi, connected in series. A pressure dividing valve, built into the pump divides the load equally between each stage.

Pressure Regulation

Figure 4 shows the pressure regulating circuit for the hydraulic beam bender. It is possible to regulate both bending and rotational pressures for experimental purposes. This is done quite simply by the use of remote control pressure valves, which alter the main relief valve operating point. The pilot operated four-way valve in Figure 4 is used to select the bending or rotational regulator. The solenoid operated two-way valve blocks the use of both regulators while functions

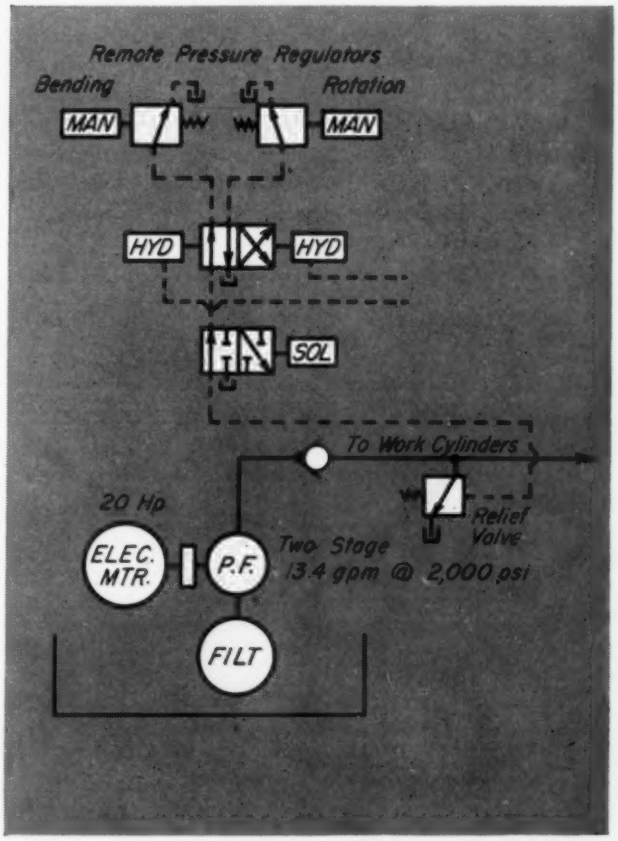


FIG. 4. Oil pressure for the five circuits is supplied by a 2000 psi pump. Pressure regulation for bending and rotation is accomplished by control of this circuit.

other than bending and rotation are being performed. During yoke lifting, yoke locking and workpiece locking the remote pressure controls are cut out of the circuit by the solenoid valve and maximum pressure is maintained by the main relief valve. A pressure reducing valve in the yoke locking cylinder circuit holds pressure in this circuit to 150 psi.

THIS RESERVOIR BAFFLE DESIGN Improves System Operation

By Martin Lipton
Compressed Air Products

ONE of the reasons for placing baffles in an oil reservoir is to help prevent entrance of foreign matter into the hydraulic system. Design of the baffle plates provides a controlled oil path from the oil return port to the pump suction port. The ideal baffling would result in the longest path between these two ports.

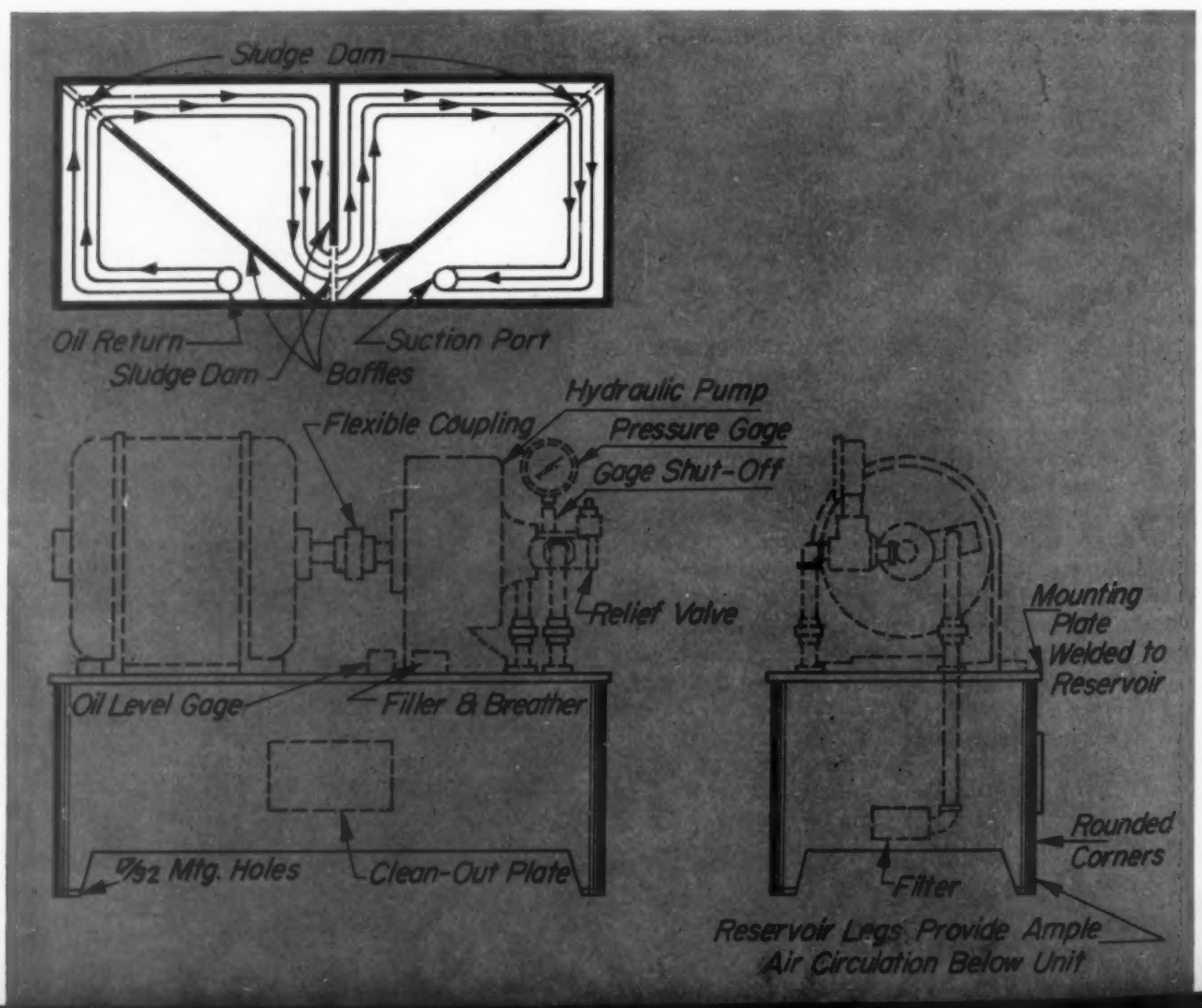
The reservoir drawing shown here, illustrates the Labyrinth layout of diffusion baffles which has been applied to many of our oil reservoirs built in sizes having a capacity of more than 10 gallons.

Fast flowing, turbulent exhaust oil returning from the hydraulic system enters the tank at the oil return. The large cross-sectional areas around the baffles cause oil to follow a path through the settling chambers. This allows sludge and foreign matter to settle and entrained air to escape. Three sludge dams prevent accumulated sludge and foreign matter from progressing through the settling chambers.

The baffles help direct oil flow to the entire area of the reservoir sides, thus cooling the slow moving oil mass by radiation. The reservoir bottom is raised off the floor to provide air circulation and further cooling. Only nonturbulent, clean, air-free, cooled oil reaches the suction line.

While this design helps to take full advantage of heat dissipation by radiation, in those applications where size limitations do not permit full dissipation of the generated heat, external oil coolers and temperature regulating valves should be used.

Of course all the care taken in designing baffles, providing access panels, locating the breather, filler and sight gauge can be lost if a reservoir having too small a capacity for the job is used. A generally accepted rule-of-thumb regarding reservoir size states that the tank should have a capacity of at least three times the volumetric rating of the pump.



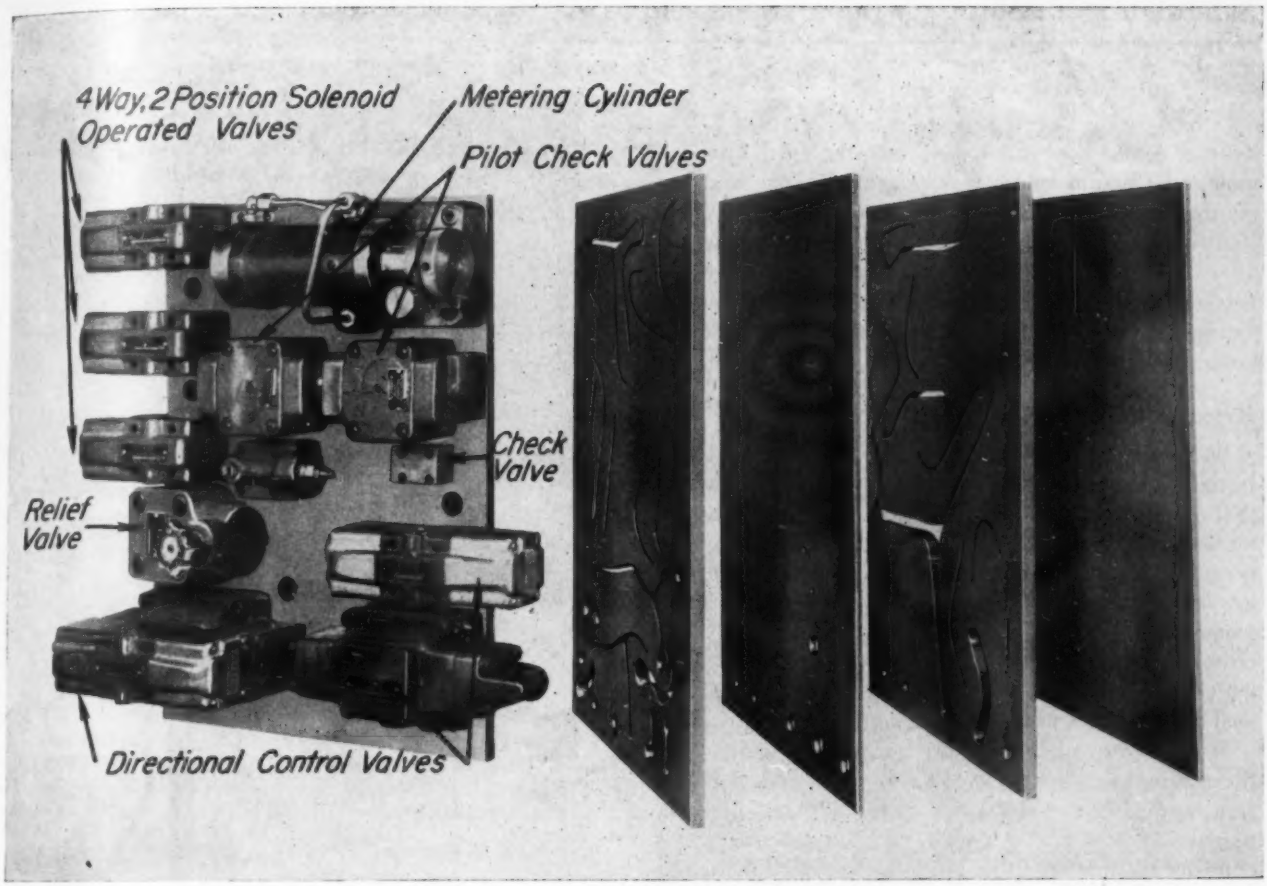


FIG. 1. EXPLODED VIEW of a 5 plate sandwich manifold used on a gear grinding machine. Plates are copper brazed together; valves are gasket mounted to the top plate.

SANDWICH MANIFOLDS

Simplify Machine Piping Layout

Here is an important development. You'll learn how sandwich manifolds have been successfully applied; how they are made; and the limitations of their application.

By Richard Moese

IT is possible to greatly reduce the number of leakage points on hydraulic systems. The sandwich manifold seen in Fig. 1 is used by The Gear Grinding Machine Company of Detroit on the machine shown in Figure 3. The manifold, designed and built

RICHARD MOESE, Almo Tool Company, Detroit, Michigan

by the Almo Tool Company, has removed approximately 50 points where leakage could occur and has eliminated many of the piping problems.

Application of the manifold on the grinder does not alter the operation of the hydraulic circuit or the valving. On this machine the same gasket mounted valves are used and the overall dimensions of the mounting panel are altered very little.

Rigid Permanent Installation

Because the sandwich manifold is a rigid, permanent installation which cannot be altered, it is important that the hydraulic circuit be firmly established before a manifold is used. The entire manifold will have to be scrapped if there are any circuit changes. Manifolds are therefore most adaptable to machines like the grinder shown here which have had the hydraulic circuit "bugs" worked out and now require a layout which will simplify construction and maintenance as well as making a neater compact assembly.

It is not possible on the gear grinder to manifold all the valving, because some of the flow control, deceleration and directional valves must be tied into the machine table. The designer of each machine must consider the machine's functions before deciding which valves can be grouped on a manifold.

On the gear grinder a 5 plate sandwich manifold is

FIG. 2. PRELIMINARY layout of manifold shows valve porting and oil passages. Because of passage crossover, passages are cut in two plates which are then separated by a third plate having only the necessary connecting ports.

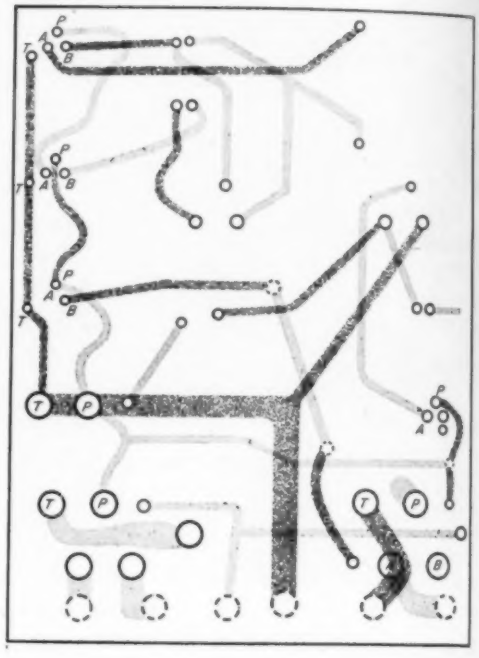


FIG. 3. THIS GEAR grinding machine shows the piping arrangement before a manifold was designed. No circuit changes were made and only the panel mounted valves become a part of the manifold.

. . . "bugs" in the operation of a hydraulic circuit should all be worked out before brazed manifolds are used . . .

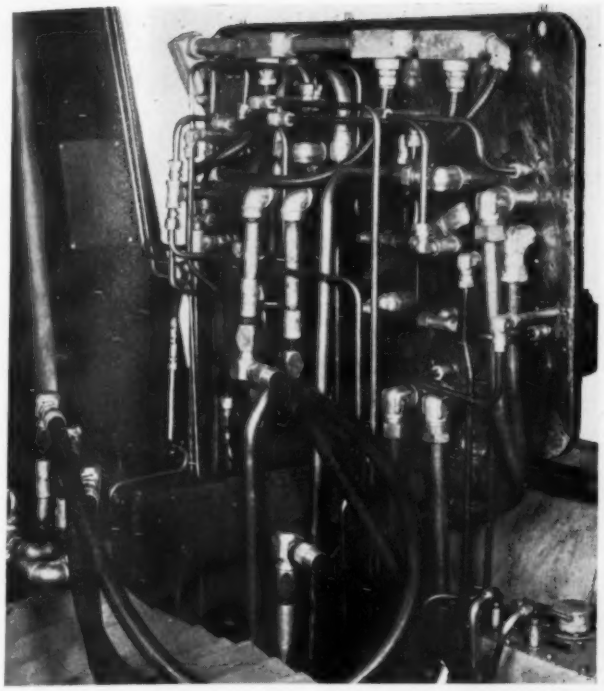


FIG. 4. BEFORE the changeover on the gear grinder this was the piping which had to be kept free from leakage. All valves are gaskets mounted on the opposite side of the panel. Constructing and maintaining this maze of piping and electrical conduit was not economical.

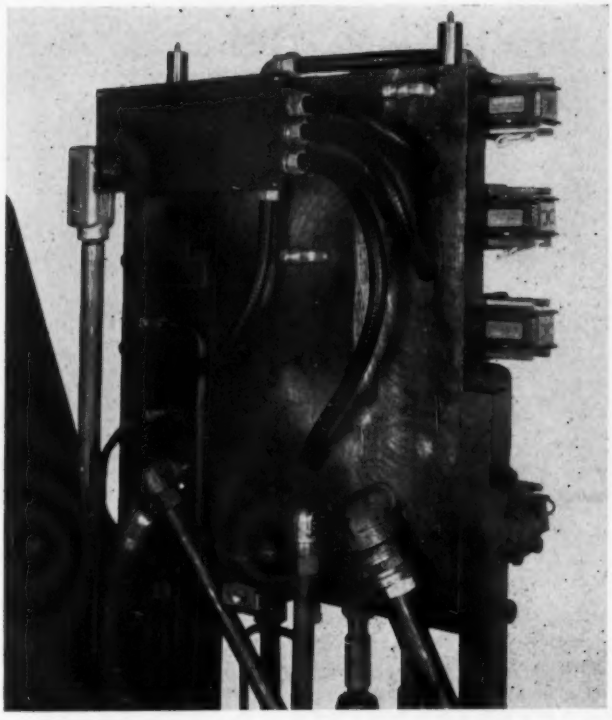


FIG. 5. AFTER installing the sandwich manifold all connections between valves are internally made. The electric junction box is readily accessible. Only pressure and return lines from the pumping unit and machine cylinders are brought into the manifold.

used. The valving and small metering cylinder are assembled on the top plate with "O" ring gaskets for the valve mountings.

Now, considering each plate from the back plate forward to the top plate. On the back plate, as seen in Figure 5, the electric junction box for the solenoid operated valves is mounted. Also there are openings for the pressure and return lines which go to the pump and tank located behind the machine, and to the table and index head cylinders. The next flat plate has torch-cut channels for oil passages, while the middle plate has transfer ports to connect with similarly cut passages in the fourth plate which connects to the ports for the valves on the top plate.

Bonding of Plates

Layout of the manifold is no problem. All passages can be cut generously large and arranged to have minimum length so that the power losses in the manifold are considerably less than the conventional tubing assembly.

Bonding of the plates in the sandwich has been the result of several years of developing a brazing technique. Copper is sprayed on the faces of each plate for the brazing operation. Then each plate is placed in position in an electric furnace and the stack is heavily loaded. Regulation of the loading and furnace temperature is critical to prevent warpage and assure full contact between all faces. Capillary action flows the copper between all contact surfaces and the excess copper flows out through the open ports. No copper remains in the oil passages. Their surfaces are clean steel.

The finished manifold on the gear grinder measures 17 x 23 inches and the 5 plates have an overall thickness of 1¾ inches. On some manifold layouts it may be necessary to use more plates to permit cutting of all necessary oil passages. A preliminary layout for a sandwich manifold used on the grinder is shown in Figure 2. Valve ports are located and then, working from a circuit drawing connections between ports are sketched in. It is quickly determined by crossover lines how many plates must be used. Several layouts may have to be made to arrive at the best arrangement.

In recent years more machine designers have established their layouts to mount valves in groups on panels. This has been a major gain over the old "Christmas Tree" circuits. Where panels are practical, the use of manifolding is the next step toward greater dependability of hydraulic equipment at lower construction costs.

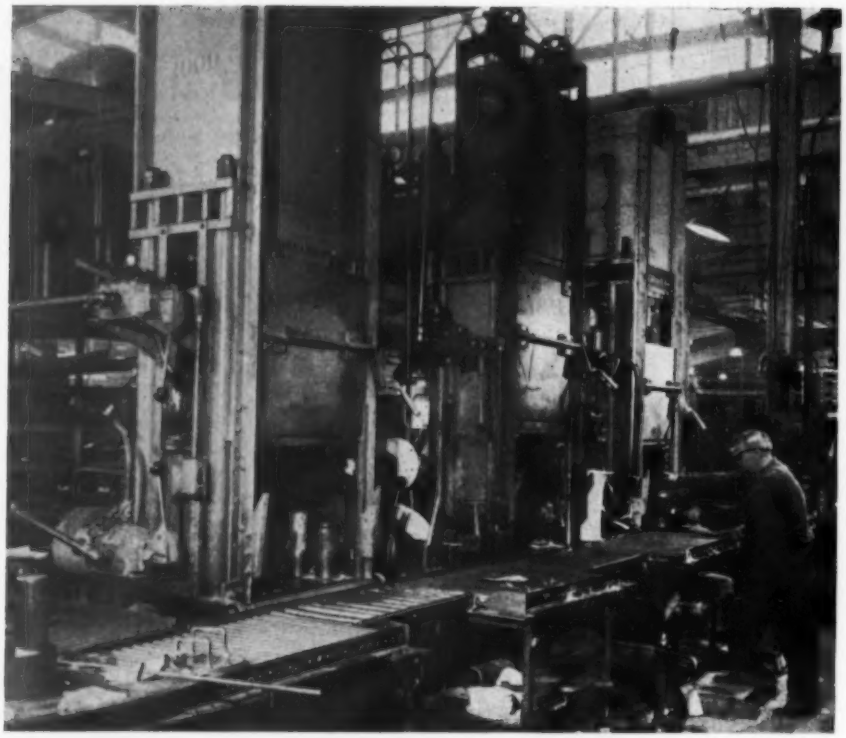
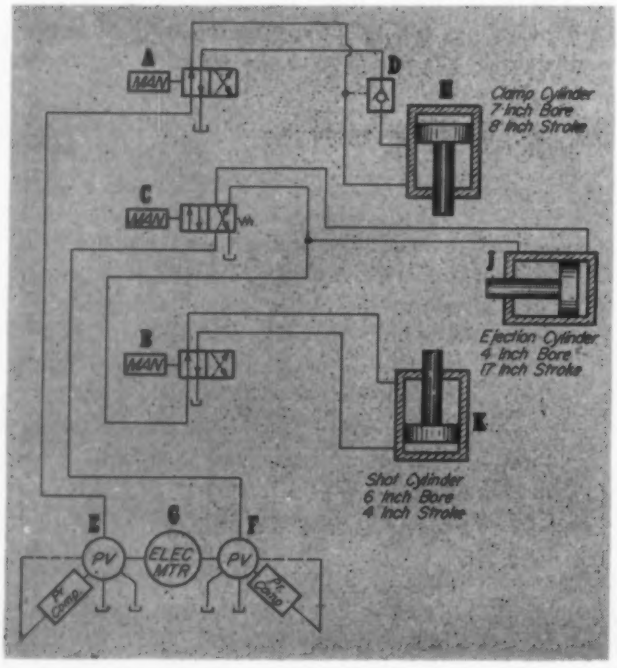


FIG. 1. A die is being placed in one of three electric motor rotor die casting machines.

Simplified Circuit Controls Special Purpose Die Casting Machine



BECAUSE aluminum die casting of electric motor rotors greatly reduces motor costs and can result in a rotor that is superior to the copper bar rotor, much work has been done to develop machines and techniques to make rotor die casting practical.

One of the early practical production setups using plant designed vertical die casting machines was made by The Louis Allis Company, Milwaukee, Wisconsin about seven years ago. The manually controlled hydraulic circuit is shown in Figure 2. Three of the machines are seen in Figure 1.

Operation is quite simple. Laminations stacked on the rotor shaft are placed in the die which is moved on the roller conveyor to the die casting machine. With the die placed in the machine, the operator ladels a measured amount of molten aluminum into the die pot above shot cylinder "K". The operator then closes a

FIG. 2. Control circuit for vertical die casting machines is manually actuated.

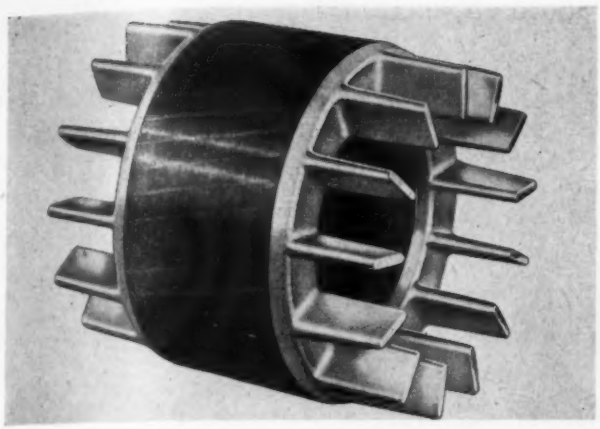


FIG. 3. Typical die cast rotor used on a 5 hp motor. Aluminum must flow through narrow skewed passages to form rings at each end.

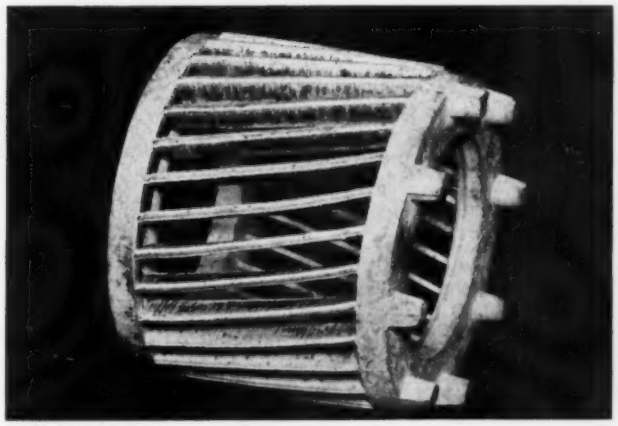


FIG. 4. Steel laminations of the rotor have been etched away to show the aluminum die cast winding or cage.

. . . die casting rotors seems to violate established rules . . . careful die design and reduction of casting temperature is required to turn out good rotors

protective shield and operates lever of valve "A" to move clamp piston "H" down to clamp the die. Lever "B" is then moved to move piston "K" up to force the die cast metal up through the die. Valve lever "B" is then returned to the position shown in Figure 1 causing piston "K" to move down. Clamp "H" is released and cylinder "J" is operated to eject the die. Removed from the machine, the die is moved down the conveyor to a station where it is opened and the die cast rotor is removed.

While the complete operation appears to be extremely simple, the aluminum pressure casting process for squirrel cage rotors seems to violate widely practiced rules associated with quality die casting. For example, the die casting engineer does not think lightly of making an aluminum casting involving an iron core which constitutes up to 90 per cent of the volume and contains 24 narrow skewed passages through which aluminum must flow to form rings at each end. Die casting of rotors is done against a cold core with aluminum which is 99.5 per cent pure. To withstand rigid electrical conductivity requirements, porosity and shrinkage must be controlled.

Rotor Die Design

To overcome all these violations of good die casting practice and come up with a good rotor, consideration has been given to efficient venting of the dies; design of injection parts to minimize turbulence of the molten aluminum; and reduction of the casting temperature.

On the Louis Allis die casting machines, two 30 gpm automatic governor, pressure compensated, variable volume pumps are used. Originally this circuit was worked with one pump. By trial and error it was found that two pumps operated from a double end motor was highly desirable. This permits better pressure control on each cylinder. A high clamping pressure can be maintained while a low injection pressure is used. It is sometimes necessary to have very low pressures on the shot cylinder, to prevent damage to the dies.

Pilot Check Holds Clamp Pressure

Pilot check valve "D" is very essential to the proper operation of the circuit. The original circuit omitted this check valve. Even though the shot cylinder is smaller than the clamp cylinder, the velocity of the motion of piston "K" caused a momentary opening of the die and resulted in dangerous splashing of the die cast metal.

Pilot operated check valve "D" was placed as close as possible to the inlet port on cylinder "H" so as to lock the liquid in the top and reduce the chances of the piston of cylinder "H" being pushed back when piston "K" built up pressure on the die, which piston "H" was holding clamped.

Each of the three machines described in this article can cast rotors weighing up to 100 pounds for 50 horsepower motors.

The great advantages offered by die cast rotors have resulted in the development and application of other vertical and horizontal die casting machines. Along with plant designed machines many commercially built machines are being used by motor manufacturers.

Greater operational ease, less maintenance, and above all, increased safety can be the results of effective use of . . .

HYDRAULIC POWER ON HEAVY VEHICLES

By R. H. Fritzges

WITH the great advantages offered by hydraulic power steering of heavy vehicles, designers of large buses have taken the step of expanding the hydraulic system to power other auxiliary devices. These devices include brakes, throttle, doors, windshield wipers and the units that control shifting of the automatic transmission from torque converter to direct drive.

There are many reasons for selecting a hydraulic fluid as the working medium on automotive equipment. Such reasons would include first of all, weight and size reduction. In addition, the hydraulic medium is incompressible and, therefore, positive in action; the equipment used in hydraulic systems is self-lubricated and possesses an inherent protection from overloading, and can be applied at a competitive or comparable cost to that of present pneumatic equipment.

The hydraulic system used on the Mack C-50 bus is completely self-contained and is a closed circuit. Fluid which is stored in the reservoir is drawn into the pump which discharges it at a maximum rate of 10 gpm through the pressure regulator and into the accumulator; the accumulator is in direct communication with the various units through a pressure line. The fluid pressure is maintained between 800 and 1000 psi by action of the pressure regulator or unloading valve, and the function of the accumulator is to serve as a storage chamber. All of the power units in this system are alike in that there is no pressure flow until actuation is desired, and then when a given function is to be performed, the valve is opened and high pressure fluid is admitted to displace a piston or cylinder. When the valve is closed, the high pressure flow is cut off and communication established between the cylinder area and the reservoir.

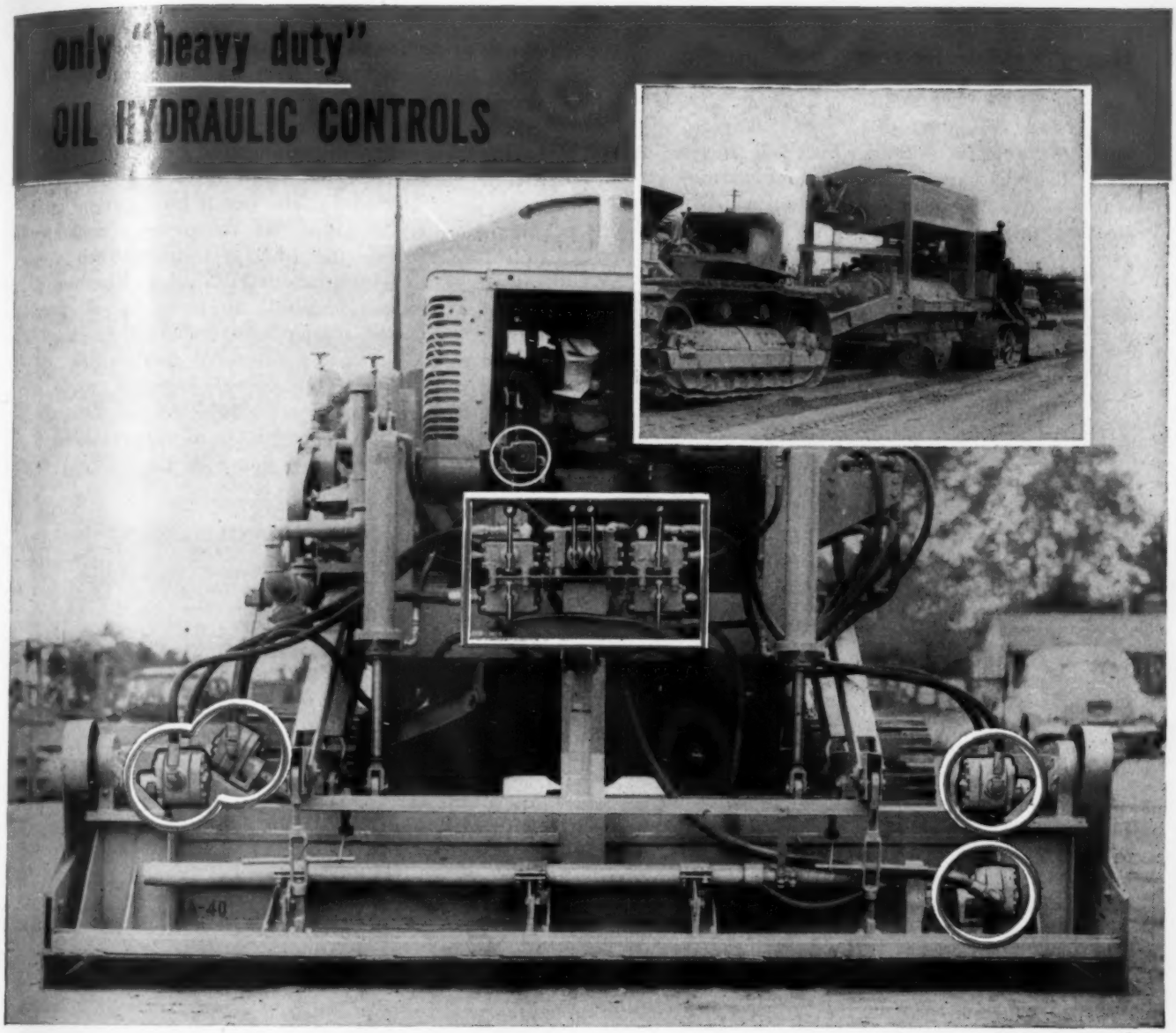
FIG. 1. HYDRAULIC steering on this bus provides for 40,000 pound-inches of torque output at 1000 psi oil pressure.

Safety Devices

We have incorporated reliable, effective safety devices to provide ample warning of any condition that may preclude complete safety to passengers. Most important of the signals is the low pressure switch which sounds a loud buzzer if the system pressure should fall to 625 psi. Now at this point, there is available a mini-

R. H. FRITZGES, Mack Manufacturing Corporation, Allentown, Pennsylvania.

only "heavy duty"
OIL HYDRAULIC CONTROLS



could so simplify such a complex power transmission

Miles and miles of old or worn out roads or highways are being reclaimed by scarifying, pulverizing and preparing the old hard surface for re-use. The aggregate is then ready for re-mixing with new bond and laid down, spread and graded ready for rolling.

The transmission of power to operate the many mechanical devices which perform such a complexity of operations has been so simplified by the use of oil hydraulic fluid power. Motors drive rotating mechanisms, cylinders actuate push-pull movements, pumps generate the fluid power and valves direct it—all work together in a series of circuits. All motions are positive and subject to complete control. All of the fluid powered operating devices occupy less space and the complete installation is engineered at substantial savings when compared to other types of power transmission.

Here again "COMMERCIAL" oil hydraulics are so noticeably in evidence.

QUALITY IN EVERY TURN

THE COMMERCIAL
SHEARING AND STAMPING COMPANY
YOUNGSTOWN, OHIO • CHICAGO, ILL. • SALT LAKE CITY, UTAH

Circle 23 on Reader Service Card

mum of 96 cu. in. of fluid which will provide for at least 10 brake applications after the warning buzzer is first heard. Since some of the fluid will be used for steering, there may be somewhat less than 10 com-

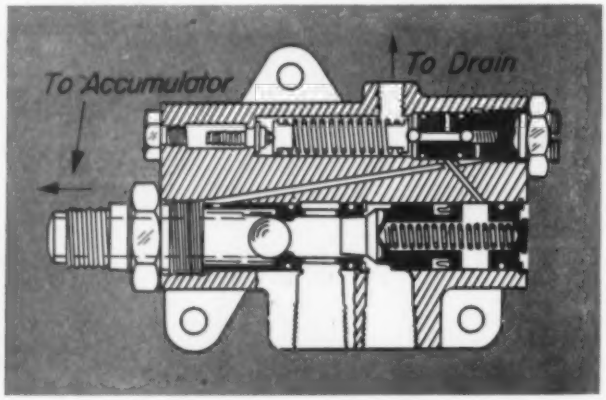


FIG. 2. PRESSURE regulator unloads pump to tank after accumulator is charged to 1000 psi. When accumulator pressure drops to 800 psi the regulator recycles.

plete brake applications available, but there is after all, little need to stop more than once. Even so, the safety factor present here will allow the driver to stop several times if he has to.

Another vital safety feature is present in the pressure regulator, Figure 1, which acts as a check valve in the event of a line failure from the pump. This is all the more important when we consider that it is extremely difficult to work in a comparable check valve in an air system due to clogging and possible freezing of the valve.

As far as the accumulator, Figure 3, is concerned, in actual tests we have found that even with a complete loss of the accumulator nitrogen charge, the pump will adequately maintain system pressure for safe operation. Needless to say, prolonged operation under these circumstances would not be conducive to long life of the pump or pressure regulator.

Still another safety device has been incorporated in the full hydraulic system and that is the low level warning. Two thermistor units mounted in the reservoir, due to their special electrical properties, warn the driver of a fluid loss in the reservoir. The warnings, spaced about 2 quarts apart as regards reservoir content, consist of a light on the panel first and final warning buzzer if the fluid level continues to drop.

System Components

The reservoir on this system has a capacity of approximately 5 gallons, although it is filled to 3 gallons, with the remaining volume for expansion. Built into the reservoir is a large micronic type filter which filters all of the fluid in the system and, of course, affords protection to the pump which depends on close fitting tolerances to maintain a suitable working efficiency.

A flange mounted, engine driven, gear type pump having a theoretical displacement of 1 cu in per revolution is used. A built-in relief valve is provided to serve as protection for the pump by insuring fluid circulation in the event that the pressure regulator fails to cut out at the 1000 psi setting. This relief valve is set to open at about 1125 psi and has an independent connection with the reservoir. Actual figures show a volumetric efficiency in excess of 75 percent at 500 rpm. With a flow rate of 2 gpm at 500 rpm, the horsepower input is between 1 and 2, while at governed engine speed of 2000 rpm, the flow rate is 10 gpm with horsepower input of approximately 8.

The pressure regulator, shown in Figure 2, serves

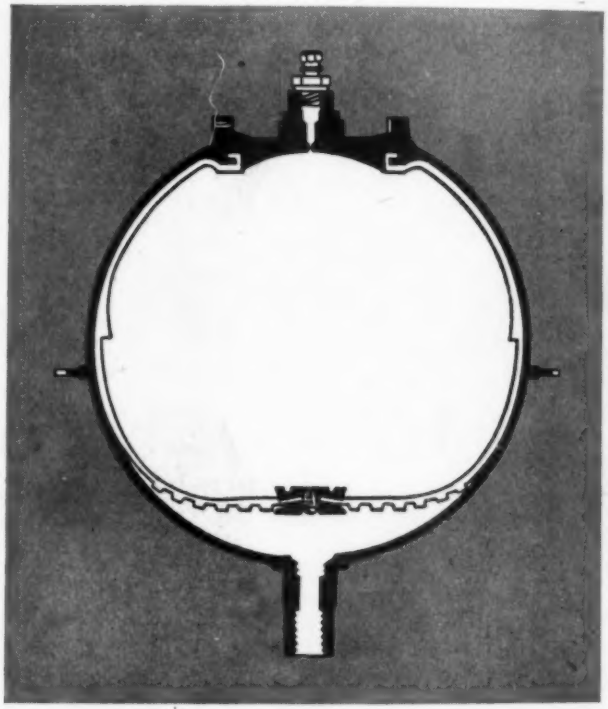
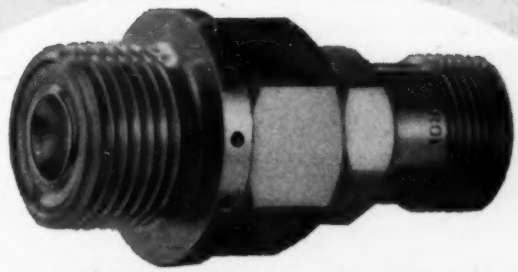


FIG. 3. SPHERICAL bladder type accumulator is precharged with nitrogen to 450 psi.

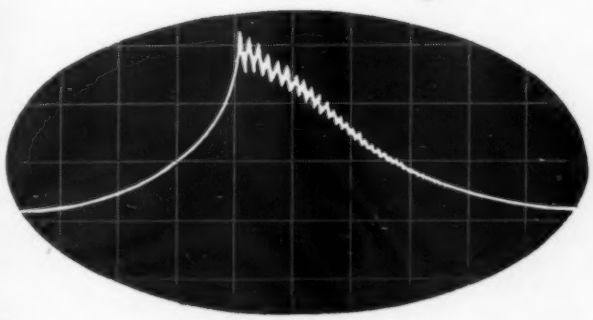
a vital function in this system. Flow from the pump is directed past the ball check valve to the accumulator and communication is established between the accumulator side of the check valve and the back side of a plunger-type valve. Pressure at this point urges the plunger against its seat, thus closing off the reservoir passage. When a predetermined pressure—in this case 1000 psi—is reached, the pilot valve moves to the left and releases pressure from behind the cut-off plunger, allowing it to open pump flow to the reservoir. Accumulator pressure forces the ball check valve against its seat and thus prevents unloading of the accumulator. At this point, power absorbed by the pump is quite small and the check valve will remain in this position until the accumulator is drained to 800 psi and the regulator momentarily recycles. It can be seen

FOR THE FIRST TIME

A COMPLETE PRESSURE PICTURE



NORWOOD CONTROLS Type EP Pressure Pickup



Versatility — for use in static and dynamic systems . . . tested and proven on gasoline and diesel engines . . . jet engines . . . rocket motors . . . blast measurements . . . high pressure, high temperature chemical reactions . . . hydraulic and pneumatic systems.

Accuracy — output linear with input to ± 1% over full static and dynamic range.

Full Scale Pressures — 500, 1,000, 2,000, 3,000, 5,000 and 10,000 p.s.i. . . . response down to 0 p.s.i. absolute.

High Frequency Response — flat to 20,000 c.p.s. . . . natural frequency up to 45,000 c.p.s.

Excellent Compensation — transducer is not appreciably affected by rapidly fluctuating gas temperatures up to 2500°F. and is insensitive to extraneous vibration.

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that this unit serves as a check valve in the main power system and will prevent the accumulator charge from escaping in the event of a break in the pump discharge line, or failure of the pump itself.

Figure 3 shows the accumulator which is spherical in shape and is made up of two steel hemispheres welded together at the equator. It contains a synthetic rubber bladder and this bladder, which has an open-

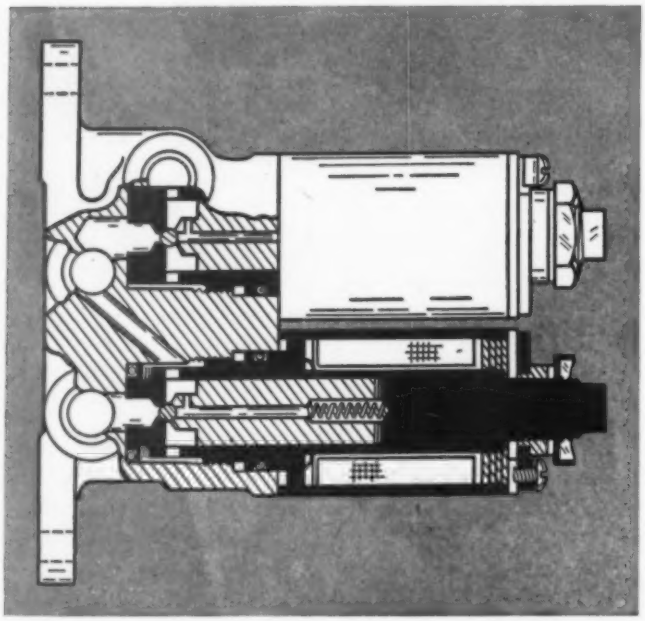

FIG. 4. SEVEN solenoid operated, three-way valves are used to control cylinder motion in the bus circuit.

ing at one pole of the accumulator, is charged with nitrogen. The oil port is located at the opposite pole and communicates to the inside of the accumulator around the bladder.

A nitrogen charge of 450 psi has been found to be most satisfactory with our operating pressures. With the accumulator fully charged with nitrogen, the bladder is extended against the walls of the shell. When the system is operating, oil from the pump enters the accumulator and compresses nitrogen in the bladder which, when fully charged, assumes a shape resembling a kidney. When a pressure of 1000 psi is obtained, the pressure regulator cuts off the flow of oil from the pump and diverts it to the reservoir. In this condition, when actuation of a hydraulic unit occurs, oil is discharged from the accumulator and it acts as a pressure source to perform the function desired. Between the regulated range of 800 to 1000 psi in this system, there will be 56 cu. in. of fluid available to perform work. When this 56 cu. in. has been used, the regulator will cycle and replenish the charge of oil in the accumulator back up to 1000 psi. In the event of failure in pump, there would actually be a much greater volume of fluid available clear down to 500 psi. This figure is 190 cu in. Assuming that no great amount of steering was being done, there would be over 15 full brake applications available down to 500 psi, starting from 1000 psi.

Control Valves

Where it is desired to control a hydraulic cylinder electrically, three-way solenoid valves, Figure 4, are used. Each valve is composed of two identical coil-and-plunger assemblies of the direct acting type and is so ported that it controls the action of a specific cylinder by either applying pressure to it from the accumulator, or unloading pressure to the reservoir. This action or function is accomplished by virtue of the fact that in normal operation, one of the coils is energized and magnetic forces induced through the coil lifts the plunger and ball off its seat to open the valve. The other valve is closed at this time. A single pole double-throw relay is used to control the action of the two coils and is either energized or de-energized, which will maintain alternate activation of two coils. The coils in the solenoid valves are quite efficient and in the 12-volt system in the bus, draw about .36 amperes.

There are seven of these three-way solenoid valves used in our bus system, all interchangeable with each other and they are used to control the operation of the clutch cylinder, direct-shift cylinder, exit door engines, brake interlock valve, ventilating damper cylinder; and one is also used to interrupt the throttle during the shift or when the doors are open.

This article was prepared from a paper presented by Mr. Fritzges at the SAE National Transportation Meeting In October, 1952.

New Book

Every hydraulic engineer will appreciate this little book which provides a simple and accurate means of estimating pipe resistance for the flow of hydraulic, lubricating, fuel and other non-aqueous fluids. Part 1 briefly reviews the practical considerations, use of diagrams and data required. Part 2 gives a series of pipe resistance diagrams for various roughness of pipe bore, viscosities and specific gravities of fluids. While flow rates and viscosities are given in British units, conversion factors for U.S. gallons and a conversion table from centistokes to both Redwood and Saybolt readings are given. Curves cover galvanized pipe, steel and W.I. pipe of standard commercial quality and very smooth, highly finished drawn tubing.

An appendix which reviews the procedure in the construction of the diagrams will be useful for those who may wish to make up their own curves for a particular set of conditions. The author is a leading British authority and the diagrams have been developed from a wide and successful background of experience.

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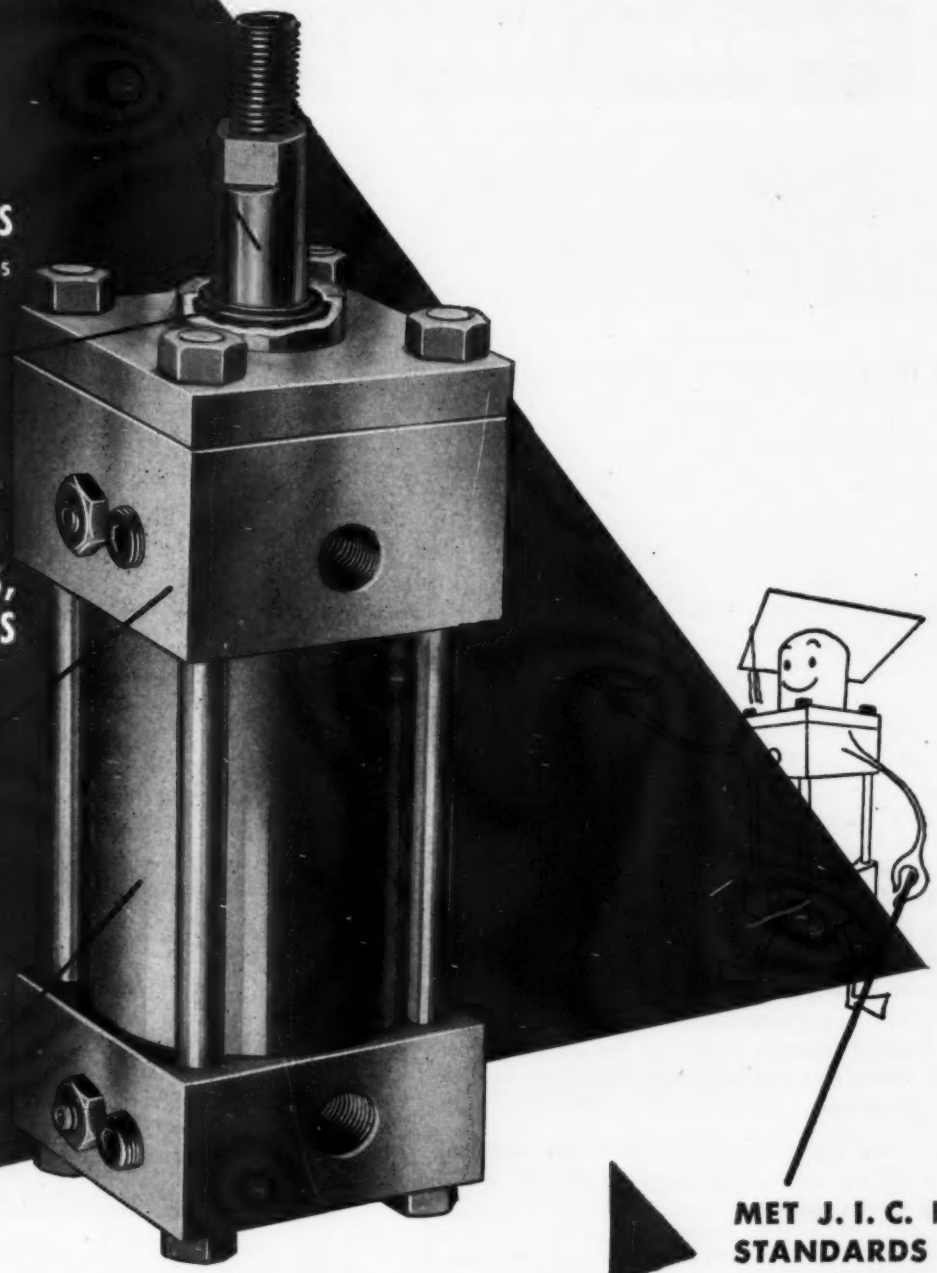

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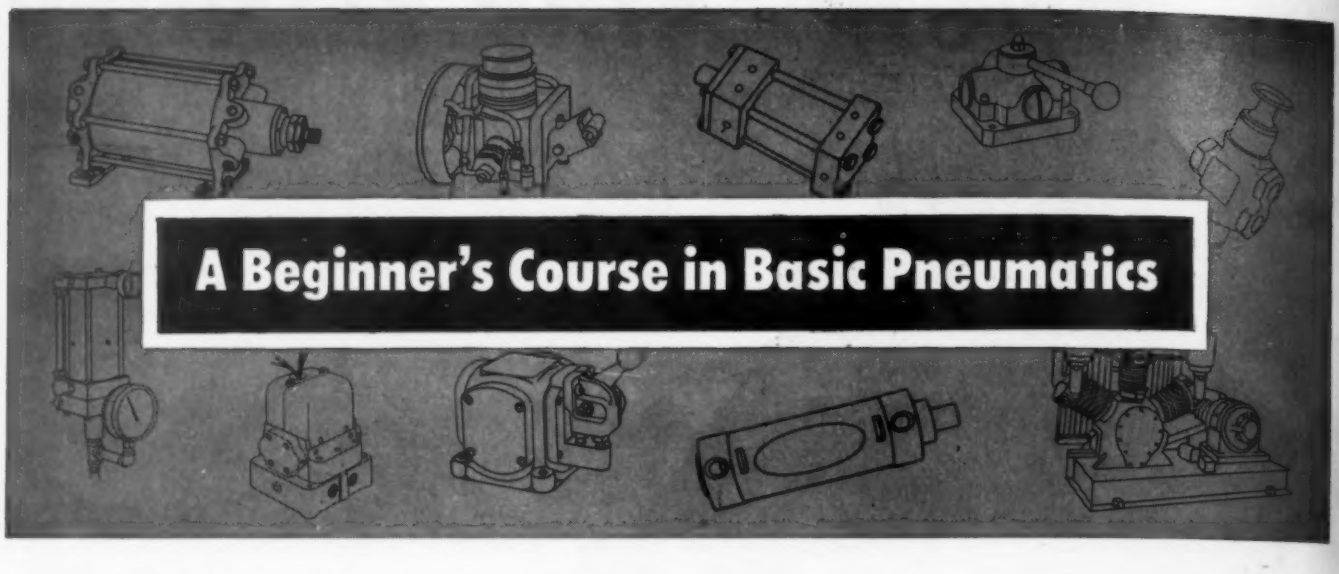


Air Cylinders

Part 1

IN its simplest form the air cylinder is made up of a cylindrical barrel closed at both ends and containing a piston firmly attached to a piston rod which passes through a hole in one end of the cylinder. The air pressure acting on the face of the piston exerts a force which is transmitted by the rod to the work. Air is admitted through a port in the piston or pressure end. Seals and bearings control the air and protect the piston rod.

We will limit our discussion to linear (non-rotating) cylinders or air motors. Rotary air motors will be discussed separately later.

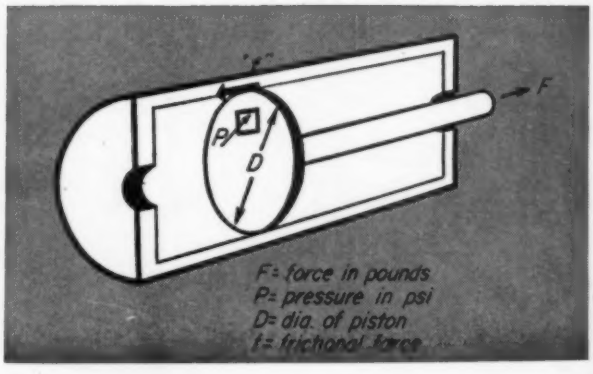


FIG. 1. THE RELATION of the three basic factors that determine the power developed by cylinders.

Force Developed by Cylinders

The first thing we want to know about cylinders is the force they develop. For a single acting cylinder:

$$F = P \times A - S - f$$

in which

F = Force in pounds
P = Pressure in psi
A = Area of piston in sq in

$$\frac{(3.1416 \times 3 \times 3}{4} = 7.068 \text{ sq in})$$

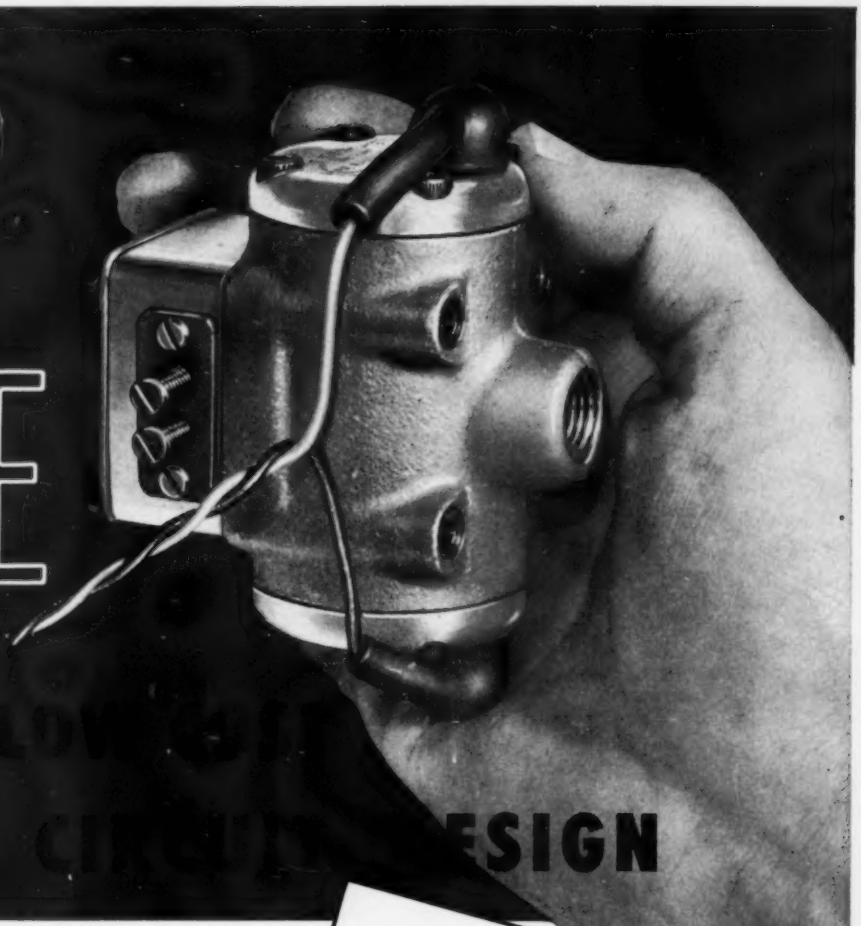
S = Spring force on rod end
f = frictional forces

To illustrate with an example, we can find the force in pounds of a 3 inch cylinder operating at 80 psi with a spring of 5 pounds force, as follows:

$F = 80 \times 7.068 - 5 = 565.4 - 5 = 560$ pounds force (frictional forces, for all practical purposes, can be neglected on well designed air cylinders).

This value can also be conveniently found by means of a nomograph (Figure 2). By laying a straightedge

LOW VOLTAGE



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The Bellows Electroaire Valve is made in ¼", ⅜", and ½" port sizes in both standard and explosion-proof types. It can be adapted for direct connection to, or remote control of any standard air cylinder of suitable capacity. It is a built-in feature of all Bellows "Controlled-Air-Power" Devices arranged for electrical control.

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across 80 psi and 3 inches we find force to be approximately 600 pounds.

When F, force in pounds and P, pressure in psi, are known, the diameter of a suitable cylinder can be found by transposing the formula to:

$$D = \sqrt{\frac{4(F - S)}{3.1416 \times P}} = \sqrt{\frac{4 \times 560}{3.1416 \times 80}} = \sqrt{\frac{2240}{251.3}}$$
$$= 8.9 = 2.98 = 3 \text{ inch D cylinder}$$

This value can also be read off the chart, Figure 2.

When F and the diameter of the cylinder are known the pressure in psi can be found:

$$P = \frac{4\ (F - S)}{3.1416 \times D^2} = \frac{4 \times 560}{3.1416 \times 9} = \frac{2240}{28.27} = 79.3 = 80 \text{ psi}$$

This value can be read directly off chart, Figure 3. In effect, we have three factors: F, force developed by a cylinder; P, pressure in psi; and A, area of piston in sq in and when any two are known the third factor is readily determined.

For double acting cylinders the same calculations are used except that there is no return spring force. To calculate force on the return stroke, the difference in area between the area of the piston and the area on the rod side of the piston (minus the area of the piston rod), must be considered. The force developed on the rod side may be found by the formula:

$$F = \frac{3.1416 \times P \times (D_1^2 - D_2^2)}{4}$$

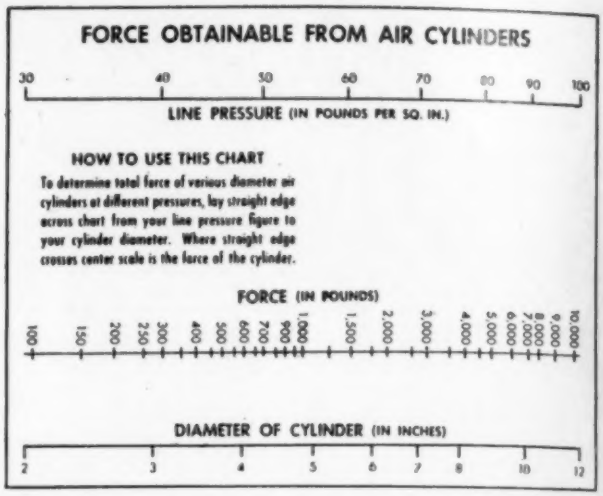
FORCE OBTAINABLE FROM AIR CYLINDERS
30 40 50 60 70 80 90 100
LINE PRESSURE (IN POUNDS PER SQ. IN.)
HOW TO USE THIS CHART
To determine total force of various diameter air cylinders at different pressures, lay straight edge across chart from your line pressure figure to your cylinder diameter. Where straight edge crosses center scale is the force of the cylinder.
FORCE (IN POUNDS)
100 150 200 250 300 400 500 600 700 800 1,000 1,500 2,000 3,000 4,000 5,000 6,000 7,000 8,000 9,000 10,000
DIAMETER OF CYLINDER (IN INCHES)
2 3 4 5 6 7 8 10 12

FIG. 2. GRAPHIC solution for F, P or A when any two are known.

Courtesy A. Schrader's Son Div. of Scovill Mfg. Co. Inc.

in which D_1 = diameter of the piston in inches
D_2 = diameter of the rod in inches

Assuming the same 3 inch piston and a rod diameter of ¾ inch, we can find the force developed on the rod side of the cylinder:

$$F = \frac{3.1416 \times 80\ (9 - .4418)}{4}$$

$$= \frac{1765.68}{4} = 441.4 \text{ pounds}$$

Developed forces on both strokes (out, the full piston area; in, the net area or less piston rod) at a

FIG. 3. CHART SHOWS the force in pounds which is developed on the head end of cylinders having bore diameters from 2 to 12 inches when the given air pressures are applied. *Courtesy Lindberg Engineering Co.*

Pressures (p.s.i.)

Bore	Effective Area		50		60		70		80		90		100		125		150	
	Out	In	Out	In	Out	In	Out	In	Out	In	Out	In	Out	In	Out	In	Out	In
2	3.1416	2.356	157	118	188	141	220	165	252	188	282	213	314	236	392	294	471	352
2 ½	4.908	4.123	245	206	294	248	343	289	392	330	441	371	490	412	612	515	735	619
3	7.068	5.841	353	293	424	350	494	409	565	466	636	525	706	584	882	729	1060	875
4	12.566	11.338	628	565	754	680	879	795	1000	905	1130	1020	1256	1134	1570	1420	1880	1700
4 ½	15.904	14.136	795	705	955	846	1113	987	1272	1126	1431	1269	1590	1414	1990	1760	2380	2120
5	19.635	17.867	982	892	1175	1070	1374	1250	1570	1425	1765	1605	1963	1786	2460	2230	2950	2680
6	28.274	25.868	1410	1290	1695	1550	1980	1810	2260	2065	2544	2324	2827	2586	3530	3215	4240	3870
7	38.485	36.079	1925	1800	2305	2160	2690	2520	3078	2880	3460	3240	3848	3608	4810	4500	5770	5400
8	50.265	47.123	2515	2360	3020	2825	3520	3300	4020	3765	4520	4250	5026	4712	6300	5900	7550	7075
10	78.540	74.563	3920	3720	4710	4475	5500	5210	6275	5960	7060	6700	7854	7456	9810	9320	11750	11160
12	113.1	109.123	5650	5460	6790	6550	7920	7650	9050	8740	10270	9820	11310	10912	14250	13650	16950	16350

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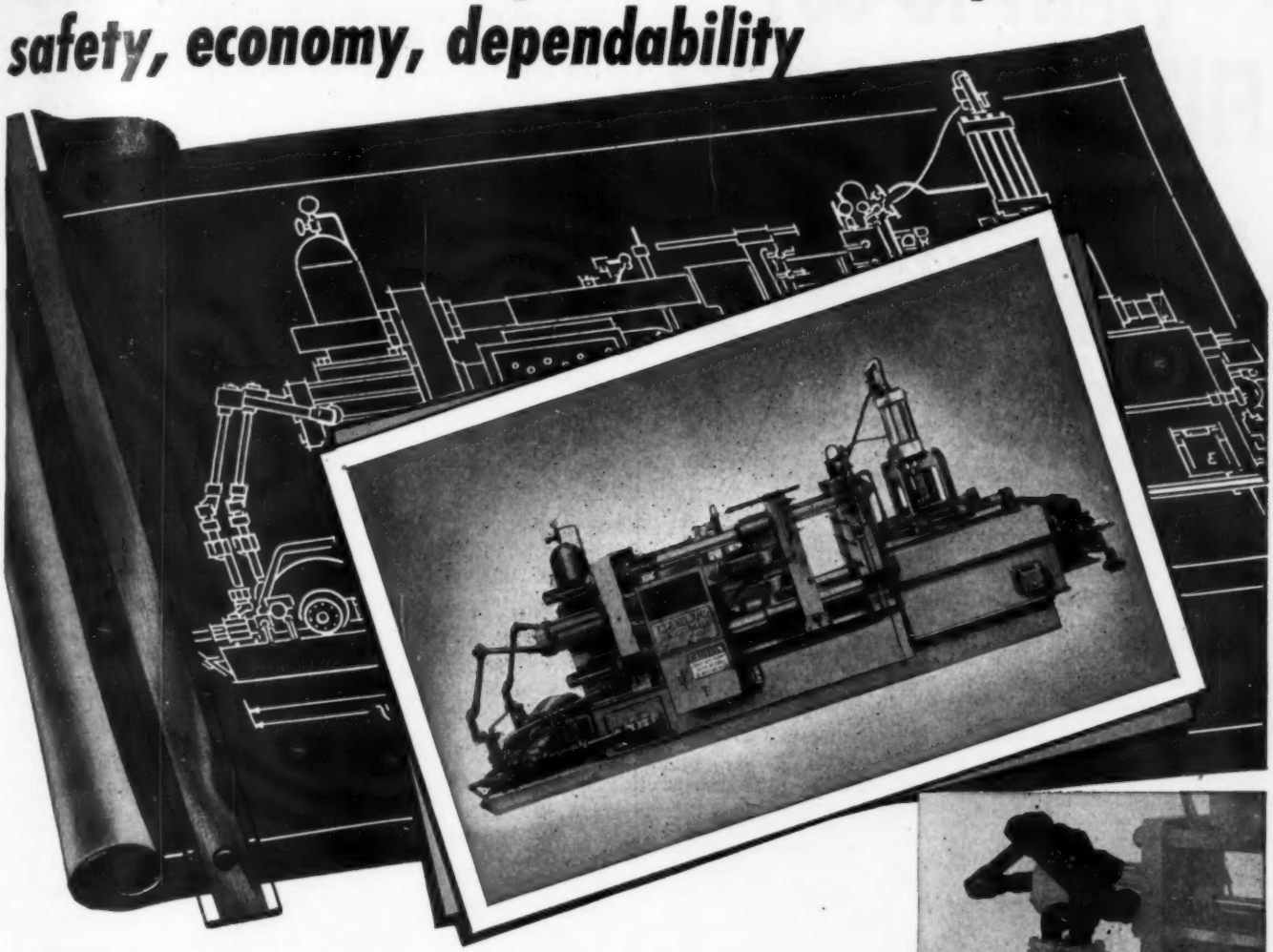

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range of pressures at which air cylinders are commonly employed are charted in Figure 3. The force on the rod side will vary with the rod diameter. It must be remembered that different values will be obtained with standard and oversize rods.

Air Requirements of a Cylinder

The second major factor to determine is the amount of air that is required to operate an air cylinder. To do this we must know the volume of the cylinder and the frequency of operation. The frequency of operation is determined in cycles or strokes per minute. Our calculations are an extension of the preceding calculations.

The amount of air used by a cylinder may be found by the formula:

$$V = \frac{L \times \pi D^2}{4} \quad \text{or} \quad \frac{3.1416 \times L \times D^2}{4}$$

Where V = Volume of cylinder in cu in
L = Length of cylinder stroke in inches
D = ID of cylinder in inches

Using for illustration a 4 inch cylinder of 8 inch stroke, we find the volume of the cylinder:

$$V = \frac{8 \times 3.1416 \times 4 \times 4}{4} = 100.53 \text{ cu in}$$

With the volume known we can then determine the amount of air required by a single acting cylinder per minute:

$$C = \frac{f \times V}{1728}$$

in which C = cu ft per minute
f = number of strokes per minute
1728 = number of cu in per cu ft

Assuming 150 strokes per minute, we determine the air requirements per minute:

$$C = \frac{150 \times 100}{1728} = 8.65 \text{ cfm}$$

This is the requirement at the operating pressure of the cylinder.

The air requirement for a double acting cylinder would be almost twice that required for the single acting cylinder. Where it may be desirable to subtract the volume of the piston rod, the air requirement of the cylinder will be the full volume less the rod.

It is general practice in selecting a cylinder to select one with a capacity of approximately 1½ times the estimated load. This will take care of inaccuracies in calculating the developed force and the friction in the cylinder (approximately 5 to 10 percent).

Conversion to Free Air

We determined that our single acting cylinder of 4 in. bore and 8 in. stroke, operating on 100 psi air at 150 strokes per minute required 8.65 cfm. It is always well to keep in mind how much compressor capacity this requirement represents. For example, if this cylinder was to be operated alone, a compressor rated at 8.65 cfm would be too small. As we learned in earlier installments, compressors are nearly always rated in cfm displacement or the volume of free air the cyl-

inders of a single stage compressor will displace (or, in case of a multi-stage compressor the volume of free air that the low pressure cylinder will displace).

This, however, is not the amount of air delivered by the compressor. This amount is determined by multiplying the displacement of the compressor by its volumetric efficiency. In our case, if the compressor had a volumetric efficiency of 85 percent at 100 psi and a 8.65 cfm displacement, it would deliver .85 x 8.65 or 7.35 cfm free air. Actually 7.35 cfm of free air would have a volume of approximately one cfm at 100 psi. (Table 2, Section 2, Part One, page 44, October 1952 issue APPLIED HYDRAULICS). By reference to this table the compressor would have to displace approximately 68 cfm free air to deliver the required amount of air to the cylinder at 100 psi.

Furthermore, this would be at a theoretical 100 percent volumetric efficiency. By dividing 68 cfm by 85 percent, we find that a compressor of approximately 80 cfm free air displacement would be needed. This is the requirement of a single acting cylinder.

While we will discuss compressor selection for adequate capacity in later installments, it is clear that it is important to estimate air requirements to meet all known and anticipated operating conditions. In practically every case additional compressor capacity for future expansions is an essential factor in selecting a compressor.

The next installment will discuss the component parts and characteristics of standard types of air cylinders.

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SERVO VALVE DESIGN for Autopilot Applications

By Martin P. Wolpin

CURRENT developments in supersonic aircraft and missiles have increased the performance requirements of autopilot control systems several fold. For stability at high speed flight, control surface actuators must overcome hinge moments of greater magnitudes than heretofore encountered, with greatly increased response and speeds. As a result hydraulic power is being applied more widely in the autopilot field because of its generally recognized weight and space advantages over electrical power where high horsepower, high speed and fast response are involved.

A major factor in the trend toward electro-hydraulic autopilots has been the successful development of the servo valve, the transfer element between the electronic controls and the hydraulic power. In fact, this trend has been dependent upon the availability of reliable, high performance valves, capable of controlling several horsepower in response to the output of an amplifier measured in milliwatts. Figure 1 is a schematic cross sectional view of a typical flow control servo valve shown with its connections to an actuator. This is a 4-way spool type valve with cylindrical type porting at the flow control edges (labeled A, B, C & D). By proper design of the inserts, which are shrunk fit in the valve body to form the bore, it is possible to manufacture this type of valve with width of the cylindrical port equal to the circumference of the spool.

Several techniques are in use for providing motion to the spool under the action of electrical inputs to the valve. These may be classified as follows:

Single Stage Valves

1. Solenoid drive. Soft iron armatures are mounted to each end of the spool and a spring is used to provide positional control (See Fig. 2a)
2. Torque motor drive. The spool is linked to an electromagnetic device whose position is proportional to electrical input. (See Fig. 2b).

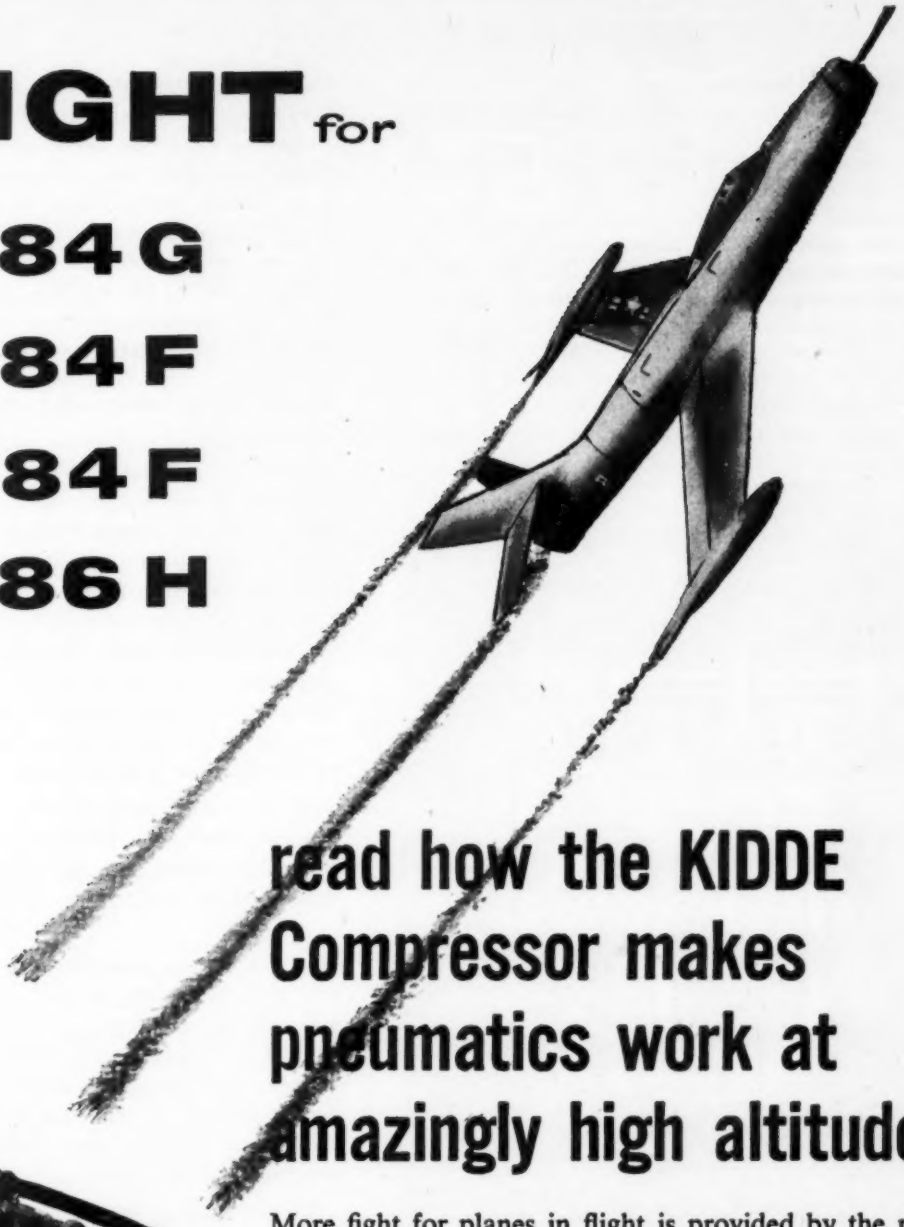
Double Stage Valves

1. Flapper valve control stage. The flapper is generally the armature of a miniature torque motor. Motion of the flapper creates a pressure difference on the spool which

MARTIN P. WOLPIN, Servomechanisms Section, Bell Aircraft Corporation, Buffalo, New York.

more **FIGHT** for

F 84 G
F 84 F
RF 84 F
F 86 H



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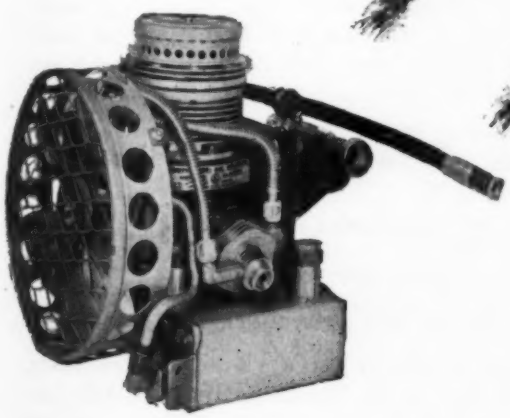

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positions it against the restraint of a spring. (See Fig. 2c).
2. Pilot valve control stage. A small pilot spool driven by a solenoid or torque motor, creates a pressure difference across the main spool. To position the main spool the use of an additional loop is required. This loop consists of a spool position pickup, such as a linear differential transformer, an amplifier and a summing network which compares the spool position signal with the input signal and uses the resultant error signal to operate the valve. The general arrangement is shown in Fig. 2d.

Single stage valves are most widely used in applications requiring the utmost in speed of response and

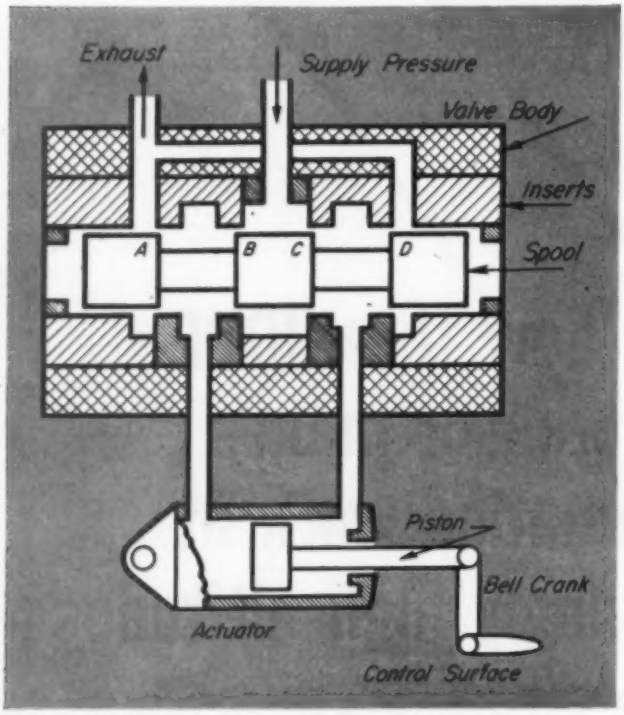


FIG. 1. Cross-section through a typical servo valve and actuator.

where low leakage rates must be held. Because of the limited forces and strokes obtainable from solenoids and torque motors of reasonable size such valves are restricted in their flow capacity. The maximum flow obtainable, for example, from a presently available single stage valve, using a specially formed spool to reduce the coersive forces of the flow, is about 3.5 gpm at 3000 psi supply pressure.

For the higher flow rates it is more advantageous to use double stage valves because of the hydraulic force and stroke amplification of the electrical input. Double stage valves are also used at low flows, where high response and low leakage are not critical, since the higher spool driving forces can more readily overcome the resistance of dirt particles and metal chips, thus affording increased reliability. Valves of this type are being manufactured for autopilot use with flow rates as high as 25 gpm at 3000 psi.

Basic to the design of servo valves, whether single or double staged, is the design of the spool and its bore. The design factors to be considered are the spool diameter, maximum stroke, overlap at the flow control edges, diametral clearance and the condition of the flow control edges. These factors are in many ways interrelated and must be satisfactorily specified, within the requirements of the application, to provide adequate power to the surface, proportional (or linear) flow characteristics, minimum leakage flow rates with the spool in its neutral position and good response.

Spool Diameter and Stroke

The diameter and stroke of the spool are determined mainly from consideration of the maximum power required at the control surface. This requirement is fixed by the maximum desired deflection of the control surface, the hinge moments expected at this deflection and the minimum time interval for the movement of the surface from neutral to full deflection. It is assumed that the hinge moment is proportional to the displacement of the actuator from its neutral position and that the time required for the spool to move in response to a signal is negligible for the purpose of calculating the diameter and stroke.

By providing sufficient force on the spool to hold it against either stop, two flow orifices of equal area are formed in series with the actuator. This area may be expressed as

$$a = wX$$

where X is the maximum spool stroke from neutral and w is the width of the opening. (For valves with full annular openings, $w = \pi d$, where d is the spool diameter.) Experimental results show that the cylindrical openings formed by sharp edged spools and inserts have the same resistance to flow as sharp edged circular orifices of equal area. Therefore we can apply the equation for flow thru such an orifice to the valve,

$$Q = ac\sqrt{\frac{2g}{w_s}\Delta P}$$

where Q = flow thru opening
c = .62
g = acceleration due to gravity
w_s = specific weight of fluid
ΔP = pressure drop across opening

Actuators driven by servo valves may be either single or double ended. In this analysis we shall consider the single ended type. Figure 3 shows such an actuator with the valve openings represented as simple orifices. From the flow equation and figure 3

$$Q_h = ac\sqrt{\frac{2g}{w_s}(p_1 - p_2)} \text{ and } Q_r = ac\sqrt{\frac{2g}{w_s}(p_3 - p_4)}$$

Letting $K = \sqrt{\frac{c^2 2g}{w_s}}$, and since

$$v_r = \frac{Q_h}{A_h} = \frac{Q_r}{A_r}$$

then $v_r A_h = aK\sqrt{p_1 - p_2}$

and $v_r A_r = aK\sqrt{p_3 - p_4}$

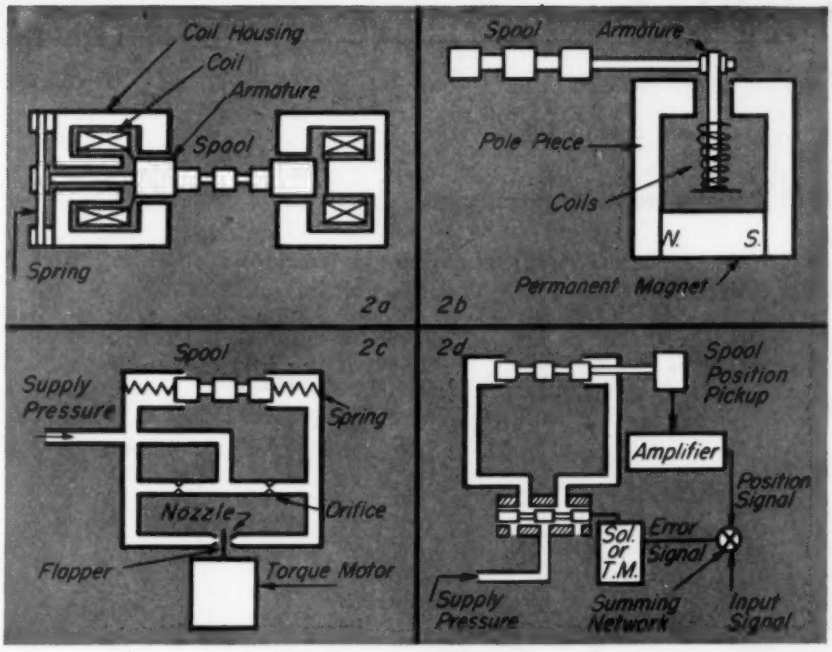


FIG. 2a. Solenoid driven single stage valve.

FIG. 2b. Torque motor driven single stage valve.

FIG. 2c. Flapper type double stage valve.

FIG. 2d. Pilot valve type double stage valve.

Solving for the pressures in the actuator

$$p_2 = p_1 - \left(\frac{v_r A_h}{a\,K}\right)^2 \text{ and } p_3 = p_4 + \left(\frac{v_r A_r}{a\,K}\right)^2$$

Neglecting the effects of friction, inertia and compressibility of the fluid the load (l) overcome by the actuator can be expressed as

$$l = p_2 A_h - p_3 A_r$$

$$= p_1 A_h - A_h\left(\frac{v_r A_h}{aK}\right)^2 - p_4 A_r - A_r\left(\frac{v_r A_4}{aK}\right)^2$$

$$= p_1 A_h - p_4 A_r - (A_h^3 + A_r^3)\,\frac{v_r^2}{a^2K^2}$$

Letting $p_1 = P_s$ the supply pressure and p_4 equal the return line pressure which is assumed to be zero,

$$l = P_s A_h - (A_h^3 + A_r^3)\,\frac{v_r^2}{a^2K^2}$$

and

$$(1) \quad \ldots\ldots\ldots\ldots v_r = aK\sqrt{\frac{P_s A_h - l}{A_h^3 + A_r^3}}$$

Similarly we may derive the expression for velocity of the piston toward the head end as

$$(2) \quad \ldots\ldots\ldots\ldots v_h = aK\sqrt{\frac{P_s A_r - l}{A_h^3 + A_r^3}}$$

Examination of the two velocity equations shows that for a given load the piston will move more slowly toward the head end and hence the required valve opening should be determined for this condition of operation.

The expression for velocity in terms of the load, equation (2), is the same as that for a parabola with its origin at $v_h = 0$ and $= P_s A_r$ as shown in Figure 4. It can be seen that for an aerodynamically loaded surface the piston moves at its maximum velocity when the surface is near neutral, and there is no load, and that the velocity falls off as the surface moves out and the load increases. In order that the surface not stall and the speed variation be kept small over the stroke, the actuator area is chosen so that the maximum available force, $P_s A_r$, is greater than the load (L) at the end of the bell crank due to the maximum hinge moment. In Figure 4, the maximum load is shown as 80% of the available force.

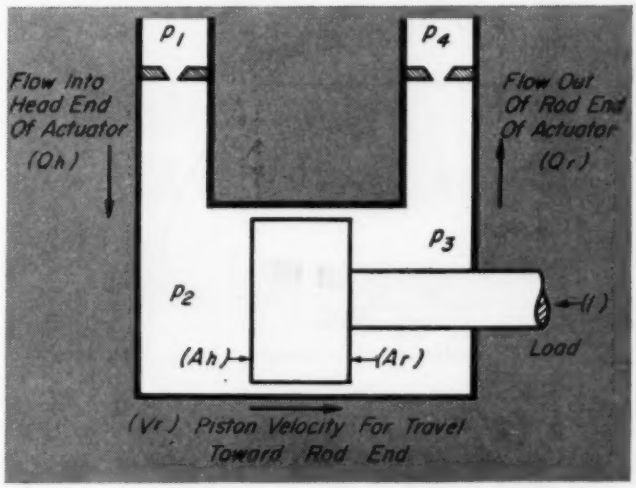


FIG. 3. Schematic representation of valve and actuator.

We can approximate that portion of the curve between zero load and the maximum load with a straight line whose equation is

$$(3) \quad \ldots\ldots\ldots\ldots v_h = V_h - ml$$

V_h = velocity of actuator for zero load
m = slope of line

The value of the slope is determined from figure 4 as

$$(4) \quad m = \frac{V_h}{L} \quad \frac{\alpha}{\beta}$$

where α and β are scaled directly from the curve.

Since the variation of hinge moment is assumed linear with piston position we may define a spring rate

$$(5) \quad K_s = \frac{1}{y} = \frac{L}{Y}$$

y = piston position from neutral
Y = max. stroke of piston

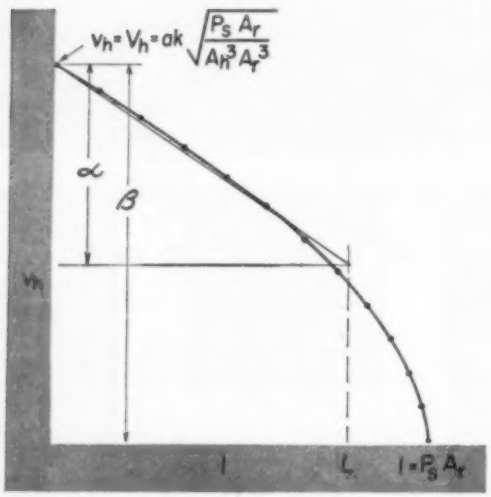


FIG. 4. Variation of actuator velocity with load.

This piston velocity v_h may be expressed as

$$(6) \quad v_h = \frac{dy}{dt}$$

Substituting (5) and (6) in equation 3 we obtain the differential equation

$$(7) \quad \frac{dy}{dt} + mK_s y = V_h$$

The solution of equation (7) is

$$(8) \quad y = \frac{V_h}{mK_s} + ce^{-mK_s t}$$

c = constant of integration

Substituting the initial condition that $y = 0$ when $t = 0$, we find that $c = \frac{-V_h}{mK_s}$ and equation (8) becomes

$$(9) \quad y = \frac{V_h}{mK_s} \left(1 - e^{-mK_s t}\right)$$

Replacing m with its value from equation (4)

$$(10) \quad y = \frac{L\beta}{K_s \alpha} \left(1 - e^{\frac{-V_h \alpha}{L\beta} K_s t}\right)$$

Solving for V_h we obtain

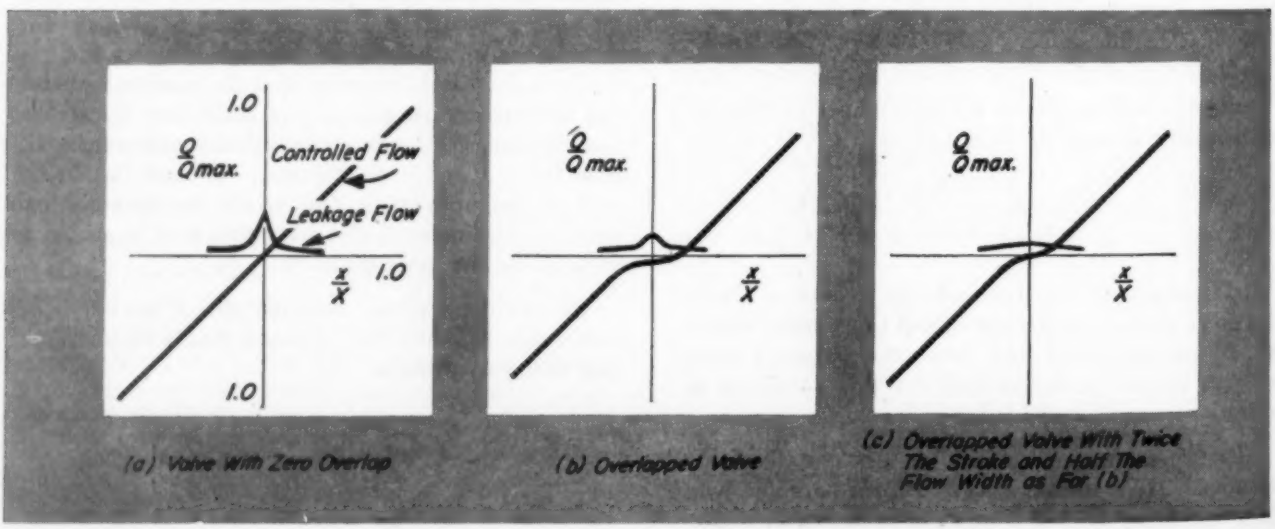
$$(11) \quad V_h = \frac{L\beta}{\alpha K_s t} \log \frac{1}{1 - \frac{\alpha K_s y}{\beta L}}$$

If we now replace y with Y, the required actuator stroke, and t with T, the desired elapsed time for the stroke, and use our definition of K_s from equation (5), we can simplify equation (11) to obtain

$$(12) \quad V_h = \frac{\beta Y}{\alpha T} \log \frac{1}{1 - \frac{\alpha}{\beta}}$$

Substituting the conditions that $v_h = V_h$ when

FIG. 5. Controlled flow and leakage characteristics with full supply pressure drop across valve.



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$l = 0$ into equation (2) we obtain as the required valve flow area

$$(13) \ldots\ldots a = \frac{\beta Y}{\alpha T} \log \left(\frac{1}{1 - \frac{\alpha}{\beta}} \right) \frac{1}{K} \sqrt{\frac{A_h^3 + A_r^3}{P_s A_r}}$$

Given the actuator stroke Y, the time allowed for the stroke T, the maximum load L, and the supply pressure P_s, the design procedure may be summarized as follows:

1. Establish A_r and A_h such that $P_s A_r$ is greater than L.
2. Lay out a parabola as in Figure 4 setting up L and $P_s A_r$ to the proper scale.
3. Determine the ratio $\frac{\beta}{\alpha}$ from the curve and substitute all values into Equation 13 to determine the flow area.

There are several considerations which affect the choice of flow width and stroke to obtain the required area; for high dynamic performance it is desirable to keep the spool's mass and stroke small; if linearity of flow with spool position is important the spool stroke should be made as large as possible; the greater the flow width, the greater the leakage rate; and, perhaps most important, the spool should not be designed with too large a length to diameter ratio or it, and the bore, will be difficult to manufacture with the required precision. Most valves, especially those designed for high flow rates, use flow widths equal to the spool circumference. For autopilot applications, representative ratios of stroke to diameter for single stage valves are in the range of 3% to 5% and for double stage valves 5% to 7%.

Overlap

The overlap of the flow control edges, when the spool is in its neutral position, has a bearing on the linearity and leakage rate. Figure 5a shows a curve of flow rate against spool position for a valve with zero overlap, plotted with dimensionless ratios to facilitate comparisons. The variation of flow with spool position is constant and this characteristic of the valve is said to be linear. From the standpoint of the servo system designed, linearity of action of the valve, as well as all other components, is highly desirable. Linear elements lend themselves readily to analysis, are more readily synthesized into practical dynamic systems and their use cuts down the number of unforeseen troubles in new systems.

Overlaps, of up to .001", are generally provided in order to reduce leakage when the valve is in neutral. It is important to keep leakage as small as possible for airborne servo valves since leakage is a drain on the power and energy capabilities of the aircraft. Comparison of the curves in figures 5a and 5b shows how the introduction of overlap reduces the leakage flow rate.

Figure 5b also illustrates the effect of overlap on the basic linearity of the flow curve. There is a pronounced change in the slope for small flow rates. In closed loop servo systems a non linearity of this sort may cause the control surface to hunt when it should be motionless. This may be corrected by increasing the amplification, or gain, of the electronic portion of the servo system. Gain increases, however, are not always desirable since too high a gain will cause unstable operation of the system and in addition may make the servo more susceptible to low power level disturbance

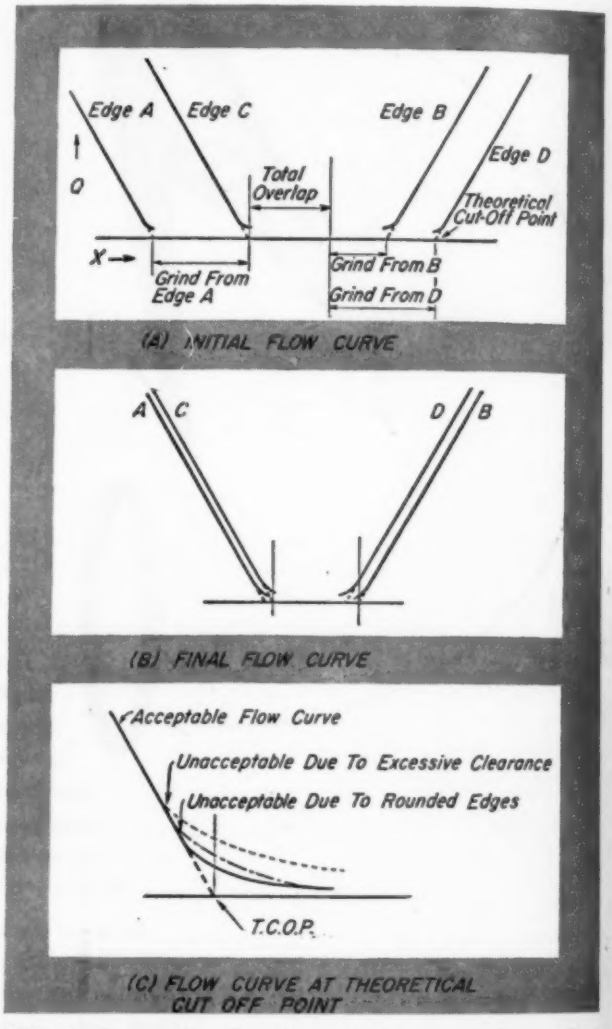

FIG. 6. Curves plot flow through the servo valve against spool position for each flow edge.

which show up as a violent oscillation of the surface.

While linearity and low leakage appear to be mutually exclusive characteristics, it is possible that, to a degree, both can be obtained if for a required valve flow area the largest practical ratio of X/W is chosen in the design. This is demonstrated by comparing Figure 5c with Figure 5b. If we take a valve represented by Figure 5b and roughly double the stroke and halve the flow width, so as to maintain the same maximum flow rate, while holding to the identical overlap the flow characteristics would appear as in Figure 5c. Note that the leakage rate is cut in half and the non-linear effect is reduced. The linearity may be

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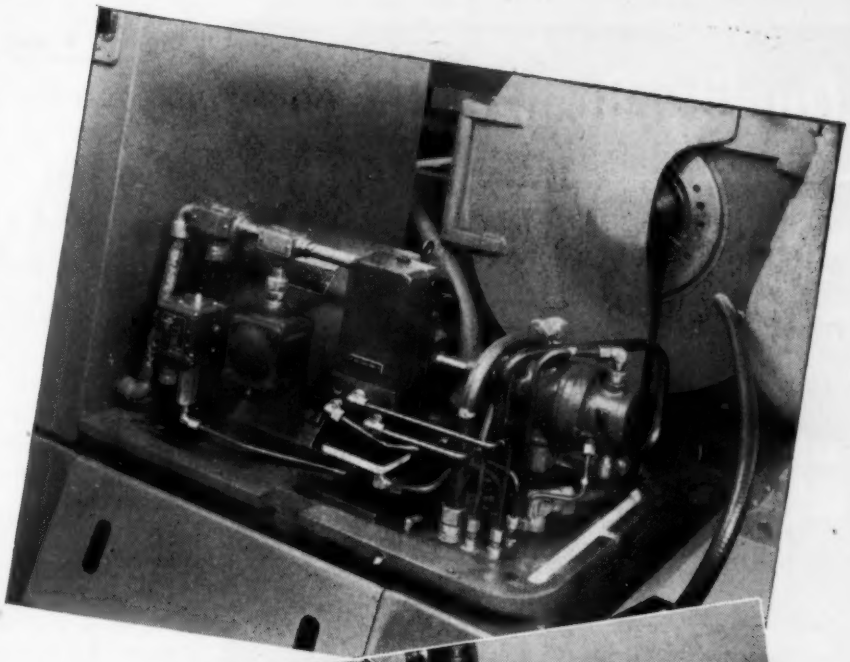

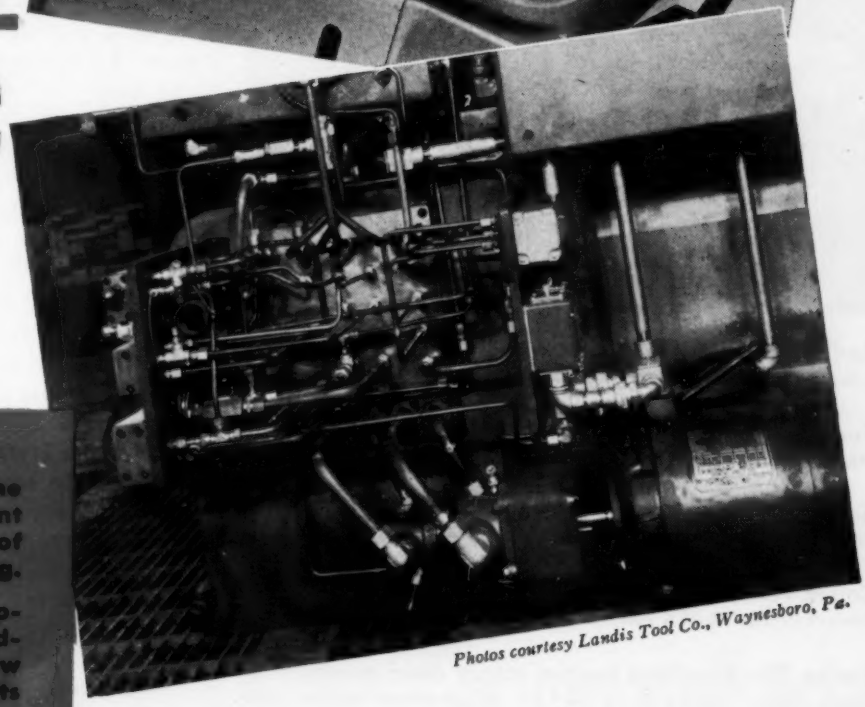

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improved even further if the original leakage rate is maintained in the second valve by decreasing the overlap.

Diametral Clearance

In order that both the overlap and leakage be kept as small as possible, it is desirable that the diametral clearance be kept to the minimum practical value. This requirement must sometimes be modified by other considerations. For example in their neutral position, servo valves act as filters, capable of removing very fine dirt particles from the oil at the flow control edges. The phenomenon of "silting up", wherein the leakage flow through a valve is observed to decrease over a period of time following the return of the spool to neutral, is attributed to the accumulation of these dirt particles which slowly choke the leakage paths. This build up of particles has an adverse effect on the valve causing a stickiness of operation which in some cases can cause the valve to be completely inoperative. For this reason the clearances used on single stage valves, because of the limited spool driving forces, are generally higher than on two stage valves in order to reduce the filtering action. The clearance on double stage valves can be held to between .0001″ and .0002″ on the diameter. For single stage valves the range is .00015″ to .0003″.

Where a servo valve is to be used in an application involving a wide range of operating temperatures, a problem similar to the stickiness caused by dirt may be encountered. For instance, if hot oil suddenly enters a valve which is stabilized at a much lower temperature, there will be some differential expansion between the spool and bore which can cause temporary sticking. This is due to the smaller mass of the spool relative to the body which allows it to respond to temperature fluctuations much more rapidly. Here again larger clearances are required by single stage valves to alleviate the effect while two stage valves can generally overpower the sticking forces.

Flow Edges

Another factor which affects the leakage of a given valve is the condition of the flow control edges. On a valve where the overlap is, as an example, specified as .0007″, a chamfer or radius of the order of .0001″ on the edges of the spool and inserts can increase the leakage by approximately 40% over that of a valve with theoretically perfect edges.

To obtain sharp edges and to maintain the sharpness against the erosive action of the high velocity oil flow, it is necessary to manufacture the spool and inserts of the hardest possible materials. Among the materials that have been used are oil hardened tool steels, hardenable stainless steel and Nitralloy.

The use of hardenable steels, coupled with the small clearances encountered in servo valves, introduces the problem of dimensional stability. In the hardening process, steel of austenitic structure is changed to martensitic by quenching. Not all the material is converted at once and it may take as long as a year for the

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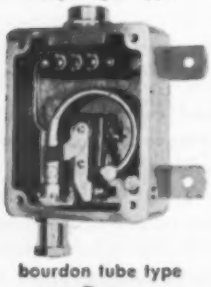
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VALVES

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remainder to make the change. This in itself would be no problem except that martensitic steel has a slightly greater specific volume than austenitic and therefore the steel will grow in size with time. To overcome this problem, it is necessary to accelerate the aging process between the time when the parts are heat treated and when they are finish ground. This is done by soaking at extreme low temperatures, then retempering and if necessary repeating the process once or twice.

Flow Inspection

The meeting of the clearance and overlap dimensions is critical to the successful performance and the reproducibility of servo valves. It has not as yet been found practical to control these factors by conventional inspection and measuring methods and as a result a technique known as flow inspection has been developed and is in general use. This method makes it possible to measure the overlap directly and to determine if the clearance, at the edge, is acceptable. In addition flow inspection makes it possible to determine the quality of the flow control edges, something which cannot be done in any other way.

After fitting the spool and bore diametrically the valve is placed on a hydraulic stand and a test made, using a constant supply pressure, of flow against spool position for each flow edge. When the results are plotted the curves will appear similar to those in Figure 6a. By extending the straight line portion of each curve to the zero flow line, we obtain the theoretical cut-off point (i.e. the position of the spool where the spool edge is in the same plane as the insert edge and at which position there should be theoretically no flow). If we wish the pair of edges A and C, (Refer to Fig. 1), to open simultaneously when the spool is moved toward the left, the cut off points for A and C must coincide. To obtain this condition, it is necessary to grind from edge A on the spool the amount of material indicated on the curve.

To set the overlap properly a point on the zero flow line is located a distance equal to the total overlap from the cut off point of edge C. The total overlap is twice the designed overlap or the distance the spool must move between the cut off points of one pair of edges to the cut off points of the second pair. This point then is used to determine the amount of material to be ground from spool edges B and D as shown in Figure 6a.

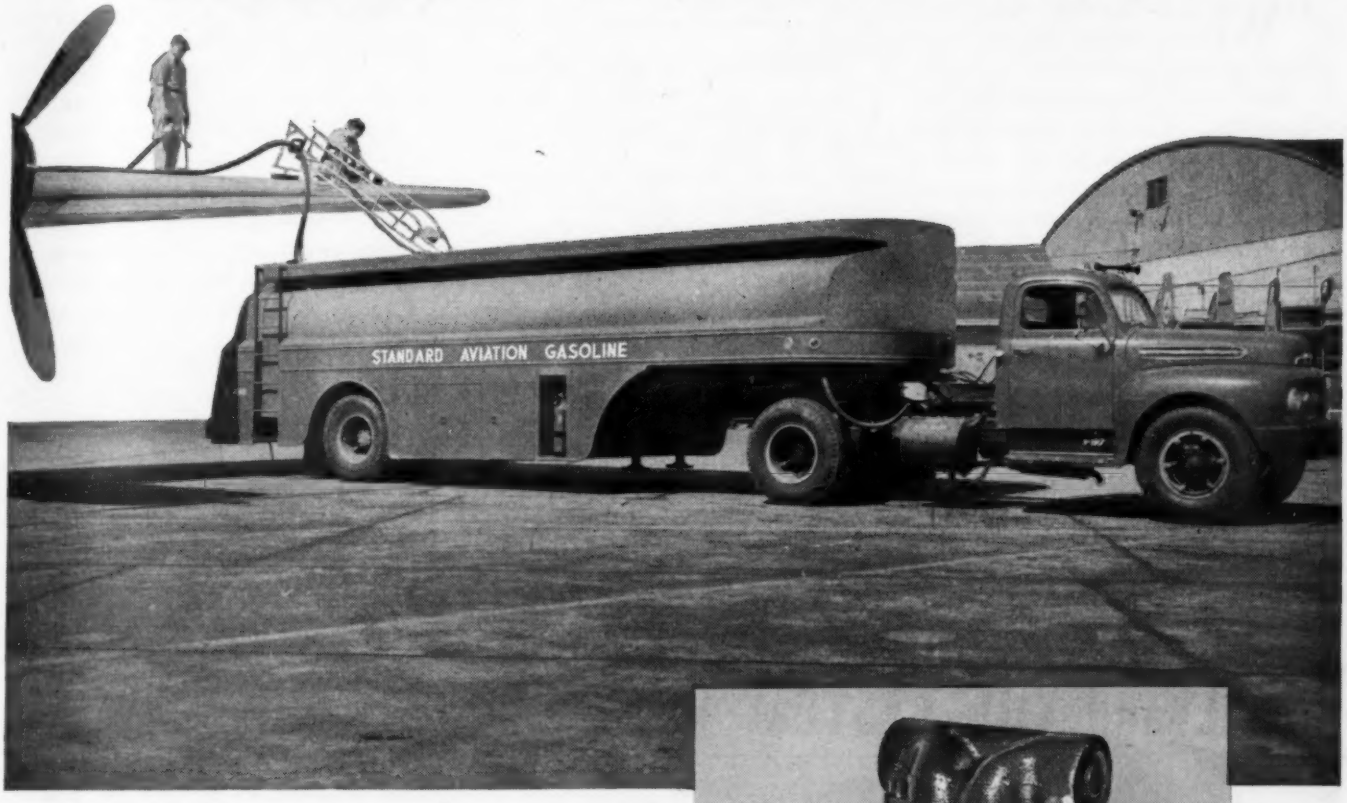
Figure 6b shows the resulting flow curves for a servo valve after regrinding the edges. It is possible by this method to have cut off points fall within .0002″ of each other and to hold the overlap within a tolerance of .0002″.

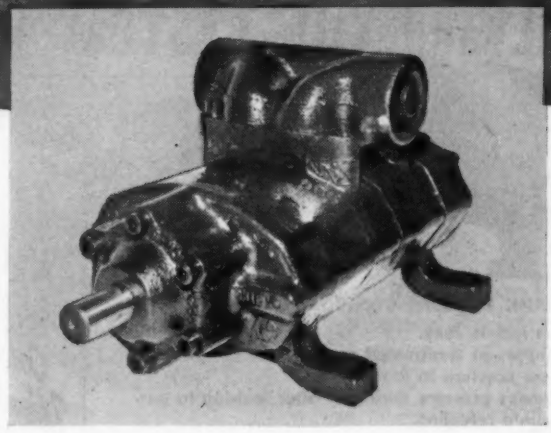
To determine if the edge condition and the diametral clearance near the edge are acceptable the flow curves are examined in the vicinity of the theoretical cut-off point. (Figure 6c). By setting a top limit of flow at the cut-off point position, it is possible to control these otherwise unmeasurable variables and eliminate a source of valve rejection.

Automatic equipment has been developed which enables an operator to set up a valve and obtain the overlap leakage information for all four edges within 10 minutes time thus making this technique highly economical for production purposes.

Standard Oil Company's Newest, Safest Aircraft Refueler is using

BERRY *Rotodraulic*





To better service today's larger multi-engined airplanes and overcome the fire hazard of gasoline engines, Standard Oil (Kentucky) designed a new kind of aircraft tender.

In a Berry hydraulic transmission, driven by power-takeoff, a new and safer way was found to drive the gasoline pump.

The hydraulically driven gasoline pump can deliver 300 gallons per minute from each hose. Hydraulic power operates a governor, permitting the driver to accelerate the engine from idle to desired speed with a button on the hose nozzle.

The small size, rugged construction, quiet operation and long, maintenance-free life of the Berry unit made it the ideal solution.

Berry may be able to solve your pump or transmission problem, too. For full details, call your nearest Berry representative. Or write us for a catalog.

BERRY DIVISION **OLIVER Iron and Steel Corporation**
PITTSBURGH 3 · PENNSYLVANIA

50 Years of Aviation Progress

"WE have done it. Succeeded in four flights 31 miles per hour against the wind."

Such was the wire that the Wright Brothers sent to their sister on the afternoon of December 17, 1903.

That morning the two determined young men had ended several years of trial-and-error preparation by making four short flights at Kill Devil Hill, just south of Kitty Hawk, North Carolina.

Orville made the first flight, covering a distance of 120 feet in 12 seconds. Wilbur flew next and made a slightly longer flight; Orville flew still further on his second try; Wilbur then flew 852 feet in a flight lasting 59 seconds. How clearly they understood what they had done is shown in a statement jointly made by Wilbur and Orville Wright later in describing the first 12 second flight as "the first in the history of the world in which a machine carrying a man has raised itself by its own power into the air in free flight, had sailed forward on a level course without reduction of speed, and had finally landed without being wrecked."

APPLIED HYDRAULICS will participate in the 50th Anniversary of Powered Flight by the publication of a special series of articles on the part which hydraulic and pneumatic components and systems have played in the development of modern aircraft. The first of these articles will appear in the August issue and continue through the rest of the year.

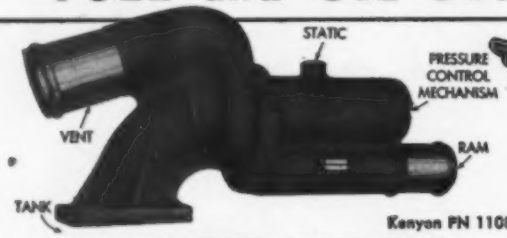
Despite official recognition by the Aero Club of America, the Wright Brothers encountered apathy and skepticism. They persisted and by 1905 had completed a flight of more than 24 miles in 38 minutes and 3 seconds.

In 1909 the Signal Corps issued specifications for a heavier-than-air machine that called for a speed of at least 40 miles per hour in a cross-country flight of 10 miles and an endurance test of one hour, both with passengers. On July 27 Orville Wright, with Lt. Frank P. Lahm as passenger, fulfilled the endurance requirements by remaining in the air for one hour, 12 minutes, 40 seconds. Three days later the speed test was made over a course from Fort Meyer to Alexandria and back. It was the first cross-country flight in America and was made at an average speed of 42.6 miles per hour. The Army purchased the plane for the agree sum of $25,000, plus a bonus of $5,000 for exceeding the minimum speed limit by two miles per hour. This airplane was the first military plane in the world.

Doolittle Is Chairman

This year the entire aviation industry is collaborating in a year long celebration marking its first half century. The National Committee to Observe The 50th Anniversary of Powered Flight, under the chairmanship of James H. Doolittle and a distinguished Executive Committee, includes a National Committee of nearly 70 nationally known figures both in and outside of the aviation industry. The members of the Executive Committee include: Admiral D. C. Ramsey USN (Ret), president, Aircraft Industries Association; C. E. A. Brown, Past President, National Association of State Aviation Officials; Joseph T. Geuting, Jr., Chairman, Conference of National Aviation Organizations; Vice Admiral Emory S. Land, USN (Ret), President, Air Transport Association of America; Howard Rough, Air Coordinating Committee; Dr. Herold C. Hunt, General Superintendent of Schools, Chicago; and Charles O. Cary, Executive Secretary, Air Coordinating Committee.

FUEL and OIL SYSTEM VALVES



Kenyon PN 11088

FUEL TANK PRESSURE CONTROL VALVE

1. Delivers air from ram to tank.
2. Closes off air supply at designated pressure.
3. Bleeds any excess pressure in tank to vent.
4. Automatically dumps pressure during or after taxi-ing to permit safe, immediate refueling.

KENYON

Kenyon PN 11180

OIL TANK FILLER-SEPARATOR VALVE

Isolates cold weather starting oil in diluted oil tank from regular engine oil in main tank, yet when required permits filling of diluted oil tank with regular oil during normal filling operation.

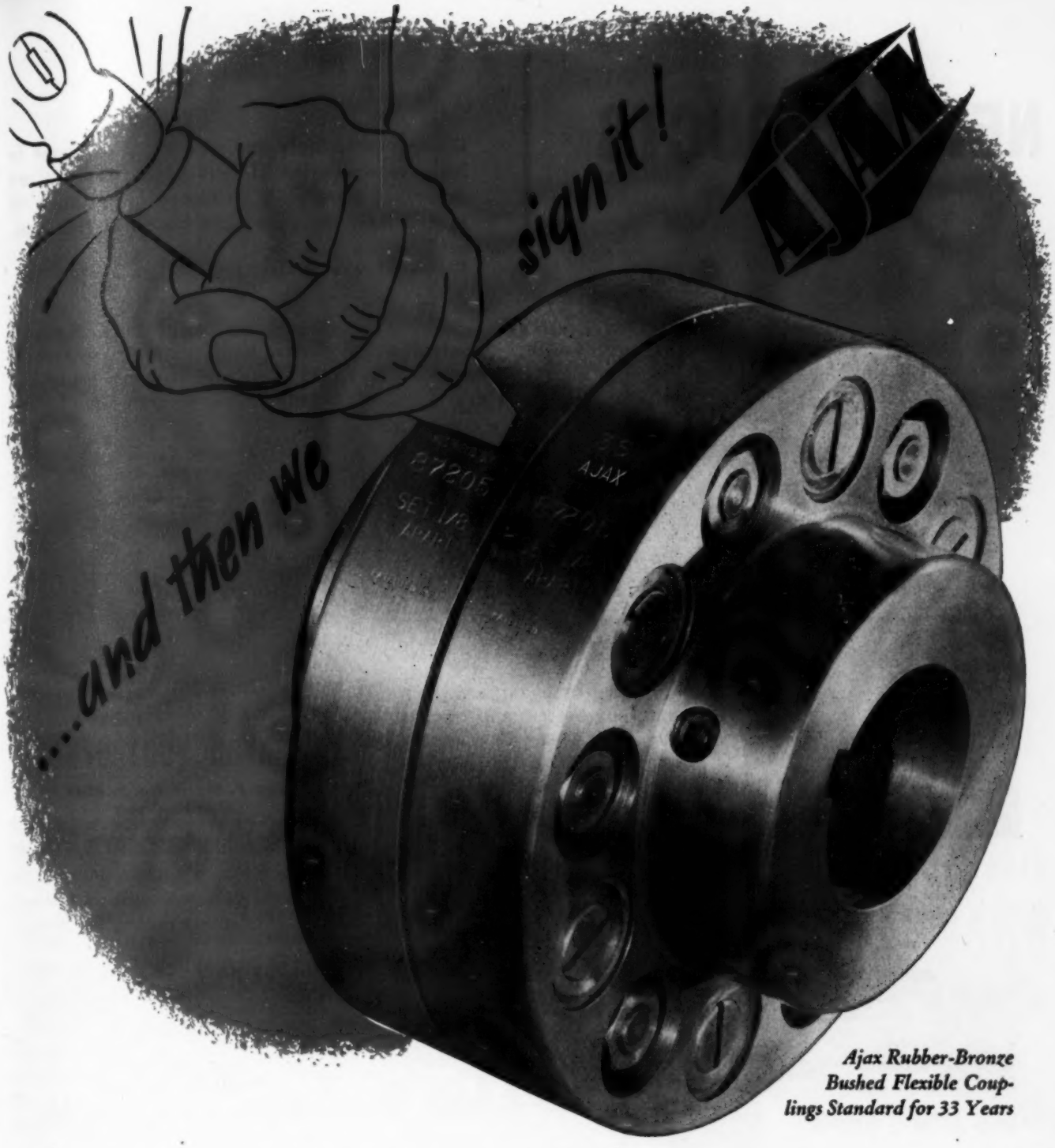
Kenyon PN 11019

SWING CHECK VALVE

Connections per AND 10060 shown. Available in 1¼", 1½", and 2" tube sizes. Also made with flanged ends or combination flanged and tube ends for individual needs. High flow, low cracking pressure.

KENYON INSTRUMENT CO., INC.

1345 NEW YORK AVENUE
HUNTINGTON STATION
L. I., N. Y.



Ajax Rubber-Bronze Bushed Flexible Couplings Standard for 33 Years

● The final and one of the most significant operations in building Ajax Flexible Couplings is stamping the Ajax name and serial number permanently into every coupling. This Ajax signature and number represents the talent, craftsmanship and experience which are responsible for Ajax performance and economy.

It is proof that Ajax has not only built hundreds of thousands of couplings, but a reputation.

Design engineers and maintenance men have learned that it pays to protect direct connected machines with these top quality couplings. Every Ajax coupling is entered on our records by its individual serial number. Analysis show that thousands of users over a 33-year period have found that maintenance cost is zero.

Furthermore, shut-down costs are cut to the irreducible minimum because of protection to bearings, armatures, impellers, and other expensive working parts. You will realize the importance of a good coupling when you remember that all the horsepower goes through the coupling. **Ajax knows couplings.**

AJAX

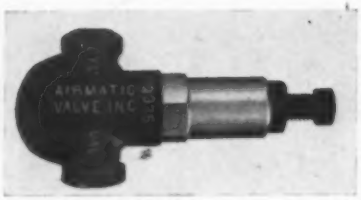
Write for New Catalog No. 55

AJAX FLEXIBLE COUPLING CO. INC., WESTFIELD, N. Y.

NEW PRODUCTS

Components, tools and equipment designed to improve operation of fluid power systems are described here . . . for more information fill in and mail the post card bound in this issue.

Continued from page 32



SEQUENCE VALVE
. . . permits single control of multi operations

Designation: Model SQ.
Sizes: Available in six standard pipe sizes from ¼ to 1¼ inches. Allows positive operation from 20 to 200 psi, air, oil or water.

Construction: Cast Naval bronze body, stainless steel poppet, seat and packing made of resilient, oil-resistant synthetic rubber.

Airmatic Valve, Inc.
Cleveland, Ohio

Circle 209 on Reader Service Card

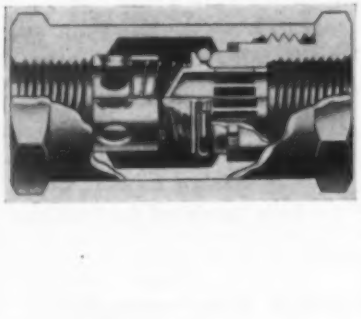
SOUNDSCOPE
. . . detects mechanical troubles

Designation: Serviceman Soundscope.
Design: Consists of a comfortable ear-piece containing a sound-box system and transmitter, with a sensitive diaphragm capable of picking up sounds which cannot be heard by the human ear, and amplifying them until they are clearly audible.

Features: Simple, compact and easy to use, the sounds of leaking valves, defective bellows, wrist pin and bearing knocks, piston slaps, grinding gears, valve noises, turbulence, and a great many other mechanical difficulties can be detected and identified.

Jas. P. Marsh Corporation
Skokie, Illinois

Circle 210 on Reader Service Card

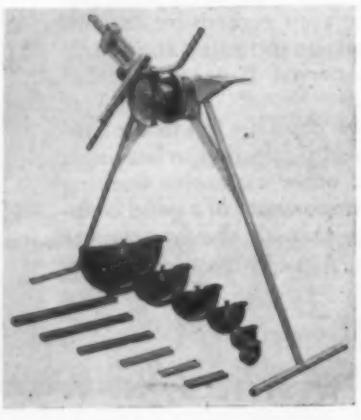


STAINLESS STEEL VALVE
. . . for use with corrosives

Feature: Incorporates Circle-seal principle; employs Teflon O-rings and gaskets for this special usage due to the chemically inert properties of this material. Dead tight sealing is provided from temperatures below –65 degrees F to 550 degrees F.
Construction: Stainless steel valves are supplied in various grades depending on the required service, with male tube or female pipe connections.

James-Pond-Clark
Pasadena, California

Circle 211 on Reader Service Card



TUBE BENDER
. . . does off-set bends

Designation: Truset
Design: The machine consists of two main components, the base and bending arm. The base is circular and carries lugs suitable for universal mounting on either bench, vice or bending stand, and around the base are holes for a stop pin, which when used in conjunction with an additional stop screw on the bending arm, allows adjustment to any angle for repetition work.

Features: Precision bending to accurate dimensions is ensured by the back stop, attached to the tube former, adjusting its grip automatically in accordance with the load applied. Formers are available for the bending cold and unloaded through any angle up to 180 degrees of tube sizes up to a maximum of ¾ inch NB gas tube and 1½ inch diameter in light gauge tube.

Chamberlain Industries Ltd.
Leyton, London, England

Circle 212 on Reader Service Card

Smoother operating!..

because they have the lowest coefficient of friction of any cylinder

For efficient performance at low pressure, the O-M Cylinder really stands out! Smoothness of bore (4 to 7 micro-inches), and self-adjusting packing reduce friction . . . floating-cushion noses *eliminate binding, dragging, jerking.* This assures a smoother stroke at low or high speeds.

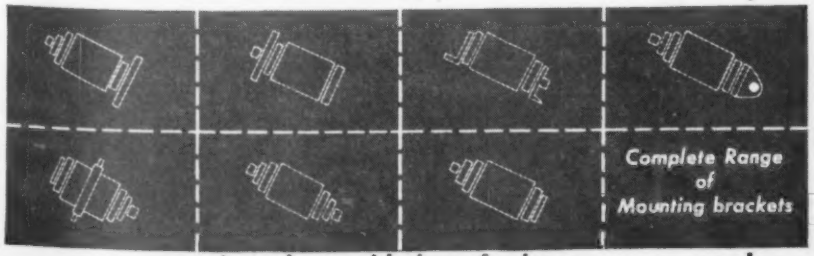
Every O-M Cylinder is All Cylinder! *Interlocking* mechanism does away with projecting tie rods and end caps, saving up to 1/3 installation space, and permitting the use of a more powerful cylinder for the job. Easier to install and repack. End plugs tapped for universal mounting. All machined steel, with bearing bronze (no castings)—easily turned down to fit in deep recesses of machines or bases.

14-DAY DELIVERY ON MOST SIZES

Available in a full range of sizes (1½" to 8" bores) with standard, 2 to 1 or oversize rods. Completely interchangeable parts.

O-M air • hydraulic CYLINDERS

Write today for FREE catalog and complete set of ½ and ¼-scale templates showing all cylinders and mounting brackets.



interchangeable bore for bore

ORTMAN-MILLER MACHINE CO.
1204 150th Street, Hammond, Indiana

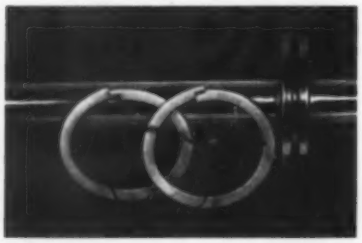
☐ Please send latest O-M Catalog
☐ Please send Complete Set of Templates

Name..... Position.....
Company.....
Address.....
City..... Zone..... State.....

Continued

PISTON RING SEAL
. . . for pressures to 5000 psi

Designation: BW Series S-11022.
Design: Combines two identical Kelon piston rings with stepped, sliding joints staggered to form a continuous seal, and a metal-



lic expander ring. The unique joint arrangement provides accommodation for dimensional changes due to heat and pressure. Installed in the piston groove the expander ring engages notches on the inside diameter of the seals and prevents relative rotation of the seals and the consequent leakage.

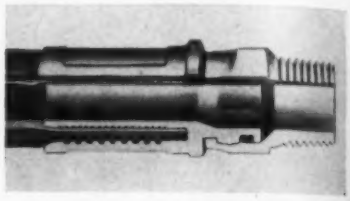
Specifications: Operating range is from –100 degrees F to +300 degrees F. at pressures up to 5000 psi.
Features: The seal is compact, responsive to bore irregularities, and has very little shift during pressure reversal. Friction at all pressures is very low.

W. S. Shamban & Co.
Culver City, California

Circle 213 on Reader Service Card

SYNTHETIC HYDRAULIC HOSE
. . . develops high burst strength

Features: Employs a tough Compar tube and high tensile synthetic fibre braid carcass. Compar also renders the hose impervious to hydraulic oils. The all synthetic construction makes the hose assemblies fatigue-proof. Offers working pressure in the 1800 to 2300 psi range.
Applications: For use in medium-high pressure hydraulic systems, suitable for farm implements, materials handling trucks, road construction ma-



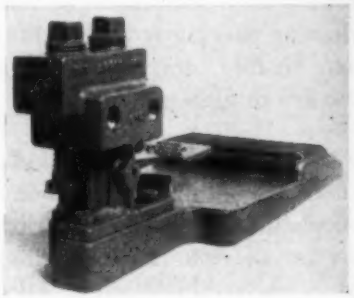
chinery and other equipment where optimum fatigue resistance and flexibility must be combined with high burst strengths.
Sizes: Lines are being offered in ¼, ⅜ and ½ inch ID. Physical pull strengths for these are given as 900, 2500 and 3500 lbs respectively.

Resistoflex Corporation
Belleville, New Jersey

Circle 214 on Reader Service Card

FOOT VALVE
. . . cuts operator fatigue

Features: Cast aluminum base has been designed to enable the operator to use the valve with the foot in a comfortable position A light touch of the foot on the pedal operates this valve. It need not be fastened to the floor and can be moved to suit the operator's convenience.



Ports are ¼ inch. Valve operates on air lines up to 100 psi and has adjustable speed control in either direction.

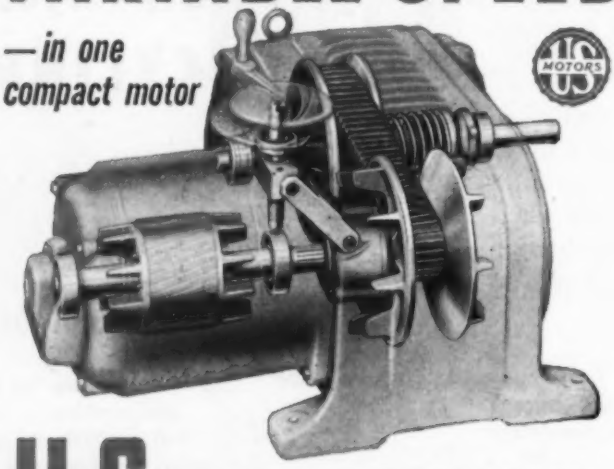
Air Fixtures, Inc.
North Manchester, Indiana

Circle 215 on Reader Service Card

LUBRICATING SYSTEM
. . . has hi-lo pressure switch

Designation: Meterflo
Design: Utilizes positive piston displacement principle, a sure method of controlling the flow of oil to every bearing under pressure. Flow rates up to 80 cubic inches per minute.
Construction: Pump units with

Simplified
VARIABLE SPEED
—in one compact motor



U.S. VARIDRIVE
...miracle motor with infinite speeds

Varidrive accomplishes in a single power unit functions that formerly required many separate cumbersome units. You can instantly vary speed for each load condition; increase production; improve operator's ability; adjust speed to overcome chatter, vibration and pulsation.

Write for new 16-page U. S. Varidrive Motor Bulletin.

U.S. ELECTRICAL MOTORS Inc.
Box 2058, Los Angeles 54, Calif. Milford, Conn.

Circle 101 on Reader Service Card

Shape of things to come

You're right from start to finish with Rockrite. Whether you use Rockrite cylinder finish steel tubing for hydraulic cylinders, shock absorbers or similar parts, you'll find there's nothing quite like Rockrite. The inside is smooth, free of surface defects—a surface that's perfect for a piston with soft packing. Smooth bore surface plus exceptionally close dimensional tolerances mean that this tubing can be cut to length and used as is. You can also make standard, interchangeable parts.

Remember . . .
to make it right . . .
make it with Rockrite.
Ask for Bulletin R7
containing fuller data.

ROCKRITE® TUBING

TUBE REDUCING CORP.
Wallington, New Jersey

DOUBLE MACHINE LIFE

THROUGH POSITIVE FILTRATION OF HYDRAULIC-LUBRICATING OILS

GENERAL AF-500 *Industrial* FILTERS

GENERAL AF-500 FILTERS are designed to do just one thing—provide low-cost, day-by-day protection of hydraulic and lubricating oils used in quality machine tools. The AF-500's highly absorbent ALL-WOOL felt cartridge safely traps solids and moisture *before* they can damage vital machine parts. Costly oils and other industrial liquids are thus kept completely clean, assuring better performance, longer machine life, and low maintenance.

DISASSEMBLES IN SECONDS!

Cleanable wool felt cartridge quickly removed simply by unscrewing center bolt and lifting off cover and washers.

AF-500 for New or Old Equipment

- Positive absorbing action removes particles as fine as 5 microns. Safely filters lubricating and hydraulic oils, paints, lacquers, and other heavy liquids.
- Eliminates harmful condensation moisture, eliminates formation of sludge and rust.
- Finest all-wool felt cartridge easily cleanable in a few minutes in any suitable solvent. Single-bolt assembly allows quick removal of cartridge from filter—without disturbing piping.
- 15-20 gallons per minute capacity depending upon liquid viscosity.
- Simple installation plan. Allows inlet to be turned to top or bottom —whichever gives the best space and piping accommodations.
- Equally adaptable as original or replacement equipment—on new or old machines.

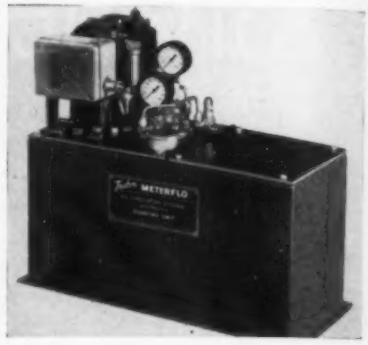
REMEMBER—We'll gladly advise you without obligation on any filtering problems.

GENERAL FILTERS, INC.
12890 WESTWOOD • DETROIT 23, MICHIGAN
CANADIAN GENERAL FILTERS, LTD.
2679 DANFORTH AVENUE • TORONTO 13, ONTARIO

New Products

Continued

or without sumps include motor, pump, hi-lo dual acting pressure switch, cartridge type filter, pressure gauges, oil level gauge and fill screen. Sturdy sump units include removable baffles



for easy cleaning of tank. Pair of constantly blinking lights, actuated by flow of oil available as optional signal equipment.

Operation: The hi-lo pressure switch connected to the warning lights, permits ready identification of too high or too low pressure; blocked line or low lubricating oil supply.

Trabon Engineering Company
Cleveland, Ohio

Circle 216 on Reader Service Card

MAINTENANCE KIT . . . for hose repair

Designation: Sav-A-Hose
Features: This device has a wire band that is formed around the

hose, then tightened and clamped with the specially designed hose clamp tool. It provides a neat clamp with no bulky obtrusions and can be used on all hose for

an absolutely tight connection that is permanent and rust proof. Properly applied bands will withstand pressures up to 500 psi.

Service: The kit comes equipped with one jr. hose band tool and 20 bands each of sizes ¼, ½, ¾ and 1 inch ID hose.

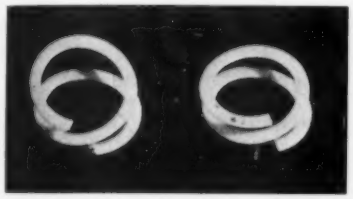
Application: Repairing all types of hose from ¼ to 1 inch ID regardless of ply.

Squire-Cogswell Co.
Chicago, Illinois

Circle 217 on Reader Service Card

SPIRAL BACK-UP RINGS . . . for O-ring packings

Features: New design to meet the demand for a Teflon spiral back-up ring that gives better protection to the O-ring. The ends are scarfed at a 30 degree angle and under pressure this spiral presents an almost flat



surface to the O-ring and prevents any marking or cutting. Design takes into consideration the actual piston groove diameter and the rod diameter of the units. This is done rather than using the nominal ID diameters of the O-rings. This new design of spiral back-ups is used with O-rings the same as with the original Teflon spirals which replaced leather back-ups in many applications.

Reid Enterprises
Los Angeles, California

Circle 218 on Reader Service Card

MANUALLY RESET VALVES . . . avoid electrical connections

Designation: Bulletin No. 8035

Features: The valve is available in two, three, and four-way construction; will give dependable service mounted in any position; operating mechanism can be rotated 360 degrees; valves can be provided with auxiliary switches for indicating lights and electrical control circuits. Operates on loss or application of pressure. No electrical power is required.

Texture-engineered for long-life efficiency

★ IN PUMPS
★ IN AIR CYLINDERS
★ IN HYDRAULIC CONTROLS

In Darcova Pumcups you get far more than ordinary cup-type packing. Pumcups are engineered in many textures and compositions—the result of years of application research. Thus there is a type *ideally* suited for use with practically any fluid under a wide range of pressure and temperature conditions.

This texture engineering is one of the reasons why Pumcups outlast most other packings at least 3 to 1. Then, add to this cost-saving advantage the fact that Pumcup efficiency remains virtually constant *despite wear.* You'll see why Pumcups are going into more and more reciprocating pumps and air and hydraulic cylinders of every description.

SEND FOR FREE BULLETIN

Bulletin 4401 covers Darcova Pumcups for reciprocating pumps; Bulletin 4502 on Pumcups for air or hydraulic mechanisms. Write for yours today and get *all* the facts!

DARLING VALVE & MANUFACTURING CO.
Williamsport 15, Pa.

DARCOVA
THE ORIGINAL COMPOSITION CUP

PUMCUPS

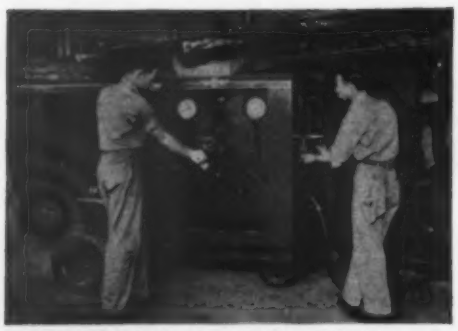
Circle 25 on Reader Service Card

GREER TOPICS

Important News of Aviation & Industrial Test Equipment

Greer Stationary Hydraulic Accessories Test Stand, shown here in Ford's Kansas City Aircraft plant, provides a shop type machine to fully check hydraulic system accessories including system pump at flow rates up to 20gpm and at pressures up to 3400psi.

Greer Dual Hose Tester, used for B-47 hose lines, checks from one to six hose lines or similar production components with pressures to 25,000psi in covered burst chamber.



Greer Portable Hydraulic Test Machine provides hydraulic test fluid for checking hydraulic systems of modern aircraft. Handles flows up to 20 gpm and pressures up to 3400psi.

How Greer Helps Ford

Greer Test Machines check complex B-47 components at Ford's Kansas City plant

This year is the fiftieth anniversary of the Ford Motor Company. Their entire history is one of quality products, economically produced. One of the reasons for Ford's extraordinary record has been its high standards of quality control.

To help maintain these high standards in the manufacture of aircraft components, Greer test equipment is at work in Ford's Kansas City aircraft plant. Complex B-47 components are put through rigorous inspection to determine their air-worthiness.

Walk into virtually any plant in the aircraft industry and you'll find Greer equipment at work. Most of the units are standard equipment ordered directly out of a catalog (yours on request). Other units were specially built to out-of-ordinary specifications by the famous Greer engineering department. These men are ready to go to work for you.

GREER
TEST EQUIPMENT

Greer Hydraulics Inc. 454 Eighteenth Street, Brooklyn 15, New York

Field Offices: 1908 West Cermak Road, Chicago, Illinois • 25 South Main Street, Dayton, Ohio
2832 East Grand Boulevard, Detroit, Michigan • and sales representatives in all principal cities

New Products

Continued

While not a solenoid valve in a true sense, it embodies all the sound engineering and careful manufacture of one.

Applications: Designed for use in oil refineries, gas plants and plants where hazardous locations make it desirable to avoid electrical connections.

Automatic Switch Company
Orange, New Jersey

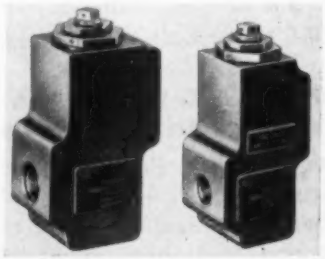
Circle 219 on Reader Service Card

RELIEF VALVES
. . . for aircraft applications

Designation: AA-31300 Series

Sizes: Tube sizes ¼, ⅜, ½ and ¾ inches at 1.2, 3.5, 6.0 and 16.0 gpm respectively.

Design: Full flow pressure 500 to 4500 psi. Available in two port and four port models. Central bore in the housing contains all of the working parts of the valve which consist principally



of a sleeve and spool subassembly, a large fixed load spring and a smaller adjustable load spring which retains a control ball on its seat.

Operation: Fully automatic and is such that the valve remains closed until system pressure

reaches the adjusted relief setting at which time it opens allowing hydraulic oil to return to reservoir through the return port. They will function properly at temperatures between –65 degrees F and 160 degrees F and at pressures between 500 and 4500 psi.

Features: The design of the four port valve is such that either or both of the pressure ports and return ports can be connected to the hydraulic system. This valve can be installed as a line coupling in a through pressure line. When only one port is used the opposing port must be plugged.

Vickers Incorporated
Detroit, Michigan
Circle 220 on Reader Service Card

AIR CYLINDER . . . for tooling applications

Designation: Series 800 Clamp Type.

Construction: Body structure is of bar stock aluminum as is

mounting end plate. Mounting holes are provided in body for horizontal mounting. The one model permits vertical and horizontal mounting. Piston rod is of stainless steel, piston is of brass and piston seal is standard O-ring. A bronze bushing is provided for guide of piston rod and entire unit is of rugged design and construction.

Sizes: This 1⅛ inch bore cylinder is manufactured in 1 inch and 2 inch stroke models.

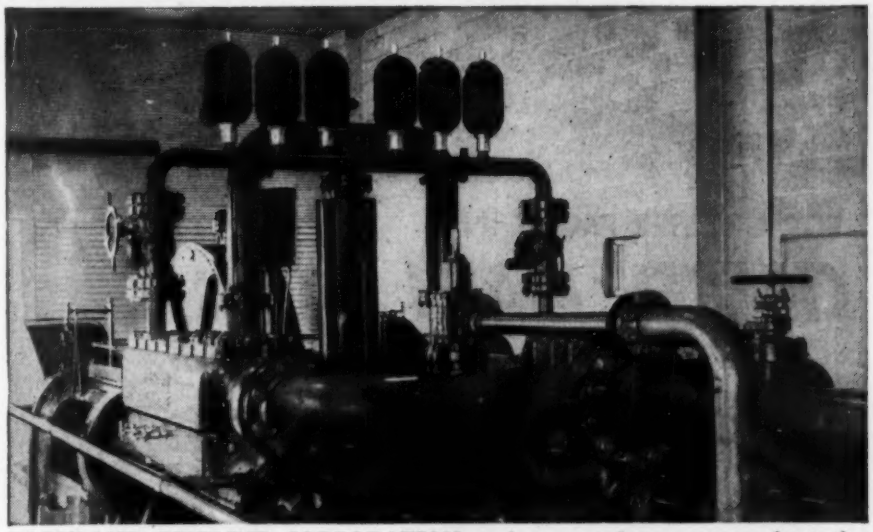
Modernair Corporation
San Leandro, California
Circle 221 on Reader Service Card

HYDRAULIC PUMPING UNIT . . . for low gpm operations

Design: All steel welded reservoir. Nitraloy gear pump in high strength aluminum alloy case. The unit is completely piped with relief valve, check-valve, reservoir filter and air breather filter. This unit is available with

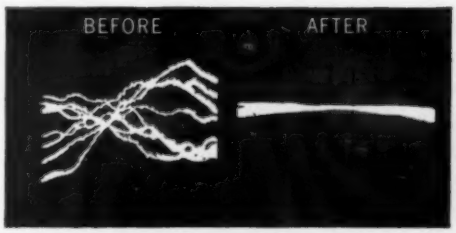
GREER TOPICS

Functions and Applications of the Greer Accumulator



PORTLAND PIPELINE CORPORATION engineers no longer worry about the problem of pump pulsations since Greer accumulators were installed on their equipment. Pressure surges from reciprocating pumps were rendered harmless. See below.

How Greer Accumulators Reduce Pump Pulsations



PROOF POSITIVE! Hydrauliscope photographs, taken before and after the installation of Greer accumulators, give conclusive evidence that pump pulsations were reduced more than 67% for Portland Pipeline pumping equipment. Write or call Greer now for special Bulletin 500 that gives complete technical data and diagrams on pump pulsation problems and corrections.

Actual hydrauliscope tests prove pressure surges can be reduced as much as 90%

The most common cause of pipeline and hydraulic system failure can be traced to the dangerous pulsations of reciprocating pumps. A positive remedy for this hazard is the versatile Greer Hydro-Pneumatic Accumulator.

This compact power package, with its unmatched ability to absorb shock, renders pump pulsations harmless. The result is a smooth, steady flow of fluid so vital to efficient hydraulic operation.

Are you troubled with a pump pulsation problem? Then let our experienced hydraulic engineers demonstrate how costly downtime can be avoided, how performance and production can be improved, how equipment can be given longer life with the installation of a Greer accumulator. Write or call today.

Greer Hydro-Pneumatic Accumulators have many other diversified functions

(1) Pressure storage chamber for main, auxiliary and emergency power (2) Pressure-volume compensator for leakage and temperature (3) Dispenser of fluids and lubricants (4) Transfer-barrier for fluids and gases (5) Shock absorber for line shock and pump pulsation.

Precision engineered to make any hydraulic system better! Complete data and diagrams in Brochure 301. Write for your free copy.

U.S. PATENTS UNDER OLAER LICENSES

GREER ACCUMULATORS

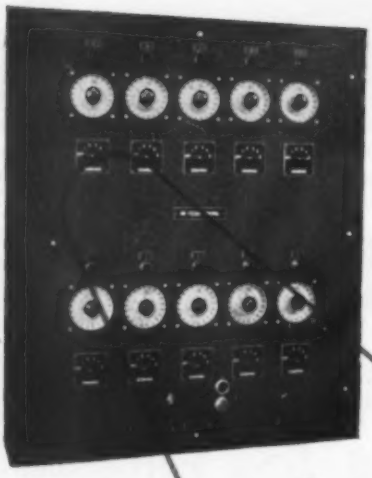
Greer Hydraulics Inc. 454 Eighteenth Street, Brooklyn 15, New York

Field Offices: 1908 West Cermak Road, Chicago, Illinois • 25 South Main Street, Dayton, Ohio
2832 East Grand Boulevard, Detroit, Michigan • and sales representatives in all principal cities

EAGLE "AUTOMATISM"

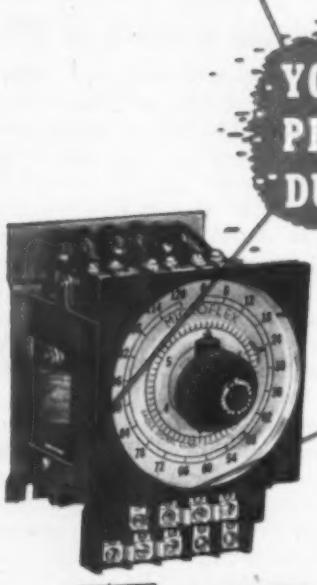
FOR GREATER PROFIT IN

CHICKEN MASH



An Eagle control panel automatically proportions ingredients from ten bins onto a conveyor belt headed for a mixing chamber. Highest standards of control and faster production increase profit for the United Coop. Farmers Inc. at Fitchburg, Mass.

YOU CAN INCREASE PROFIT IN YOUR INDUSTRIAL APPLICATION



Eagle builds a timer or a complete control panel of the right timers to increase profits for your industrial application. Send your industrial application problem to Eagle, "know-how" engineers.

EAGLE TIMERS WILL MAKE YOUR MACHINES AUTOMATIC

EAGLE SIGNAL *Industrial Timers*

EAGLE SIGNAL CORPORATION MOLINE, ILL.

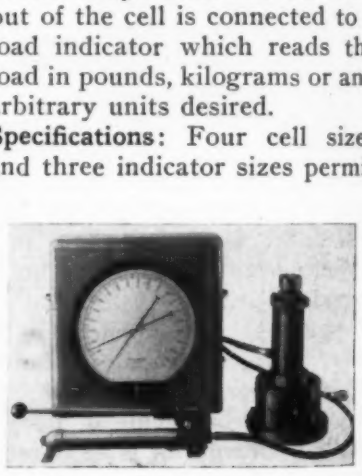
or without motor.

Capacities: .8 to 2.8 gpm; pressures up to 1200 psi.
Applications: For wherever there is need for a low cost hydraulic pressure unit.

Hackett Brothers, Inc.
North Manchester, Indiana
Circle 222 on Reader Service Card

FORCE METERING SYSTEM . . . is completely portable

Operation: The unit precisely weighs the force as it is applied. The force is exerted by a hydraulic jack, mounted on a high precision hydraulic cell. The output of the cell is connected to a load indicator which reads the load in pounds, kilograms or any arbitrary units desired.
Specifications: Four cell sizes and three indicator sizes permit



the choice for intended use. Indicators available in 8½, 12, and 16 inch sizes and calibrates them in 24 ranges from 0-500 to 0-100,000 lbs.
Application: The portable calibrated thrust system permits direct weighing of large loads. It allows application of an exact force anywhere in plant or in the field. Provides a temporary thrust or weighing arrangement with accuracy equal to permanent installations.

A. H. Emery Co.
New Canaan, Connecticut
Circle 223 on Reader Service Card

RUBBER HARDNESS TESTER
. . . measures to laboratory standards

Designation: Wallace I. S. O. Hardness Tester.
Design: The load is applied to the indentor by means of weights. Readings are taken from a sensitive dial gauge of standard design with a specially printed scale. An electric vibrator is built into the base to overcome friction and sticking.

Features: Instrument conforms to the new method of test recommended by the International Standards Organization (ISO/TC/45) which is being studied by ASTM. Readings from this test can be related to the Shore scale; for practical purposes readings are identical between 30 and 100.

H. W. Wallace & Co. Ltd.
Croydon, Surrey, England

Circle 224 on Reader Service Card

ELECTRONIC TIMER
. . . for precision

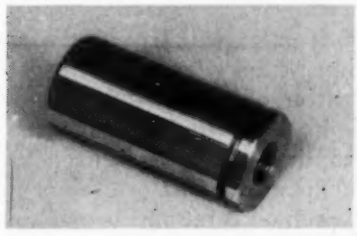
Designation: Type 30HL1
Design: To provide in a single timer for the four fundamental types of timing. The basic electronic circuit is self-compensating for changes in line voltage and, for this reason, accuracy does not vary from day to day. It employs only one electron tube and one relay.
Features Is an automatic timer for intervals from 1/20 seconds to four minutes. Provides four basic types of timing, interval, delayed action, automatic repeat and programming. All these combinations are incorporated and may be utilized by merely changing external connections to the terminal board.
Applications: For process control machine timing and other industrial applications.

Photoswitch Incorporated
Cambridge, Massachusetts

Circle 225 on Reader Service Card

CHECK VALVE
. . . has unusual tight seal

Design: In place of the conventional O-ring for its seal, this check valve has a valve seat formed of two hardened steel pieces which are designed, ground and lapped for long life. The valve which consists of seven parts, has only one moving part. Made in forged aluminum



for aircraft and in steel for commercial application. In all sizes, internal passage areas are in excess of the pipe size being used.
Application: Prevents reversal of flow of air, oil, water and chemicals, providing control lines with a minimum of pressure drop and positive sealing against return flow. No pressure is lost through the valve. Cracking pressure is five psi or less.

Anco, Inc.
Providence, Rhode Island

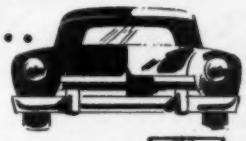
Circle 226 on Reader Service Card

LIMIT SWITCH
. . . can operate four circuits

Features: Developed as an inexpensive answer to switching circuits having two different currents, phases or voltages, but which must be switched at the same time. The new double pole

Would you rather drive

this . . .



or this . . .

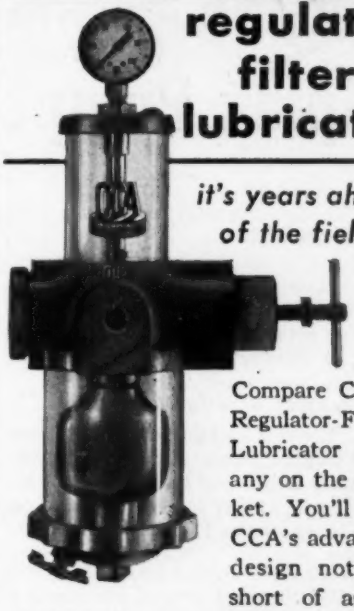
FOR YOUR PLANT INSIST UPON THE

CCA

FOR COMPRESSED AIR

regulator filter lubricator

it's years ahead of the field!



Compare CCA's Regulator-Filter-Lubricator with any on the market. You'll find CCA's advanced design nothing short of astonishing! It's more compact—all in one unit—saves space. Installation involves just 2 pipe connections. (Remember—added connections mean added chance of leaks, added expense). It supplies metered lubrication automatically. Filter removes liquid water by centrifugal action. Unit provides piston type regulation —down to ¼ lb. WITH PRESSURE RELIEF FEATURE BUILT IN. CCA is your best buy . . . by far. Stocked in principal cities. Catalog on request.

CCA PRODUCTS DIVISION
BRECO MANUFACTURING CO.
309 E. SARATOGA ST. • BALTIMORE 2, MD.
Complete line of compressed air line equipment-including Filters, Lubricators, Regulators, DeHumidifiers

KOBE Heavy Duty High Pressure

Triplex Pumps

Case History A 5: In June, 1948, 2 Kobe Triplexes were installed in the California Plant of the Ohio Rubber Company, makers of automotive molded and extruded rubber products. The specified requirement was to operate 7 hydraulic molding presses 24 hours a day, 6 days a week, at pressures of 2,000 psi.

"Extremely Satisfactory Service"

Mr. L. Kotich, Chief Engineer for the company states, "These pumps have given extremely satisfactory service—even when called upon, as they sometimes are, to operate for as long as 3 weeks continuously."

Again the Kobe Triplex proves its right to be called the most dependable source of high pressure hydraulic power available.

Features:

- Pressures—To 5,000 psi (standard) To 20,000 psi (special)
- Volumes—To 60 g.p.m.
- Power Ratings—15, 30, and 50 H.P.
- Integral Double Reduction Gears
- Integral Electric Drive (optional)
- Easily Interchanged Plungers and Liners
- Built-in Pressure Lubrication
- Easily Accessible Ball Type Check Valves

Write for Bulletin

KOBE INC., Division of Dresser Equipment Co., 615 NBC Bldg., 815 Superior Ave., N.E. Cleveland 14, Ohio

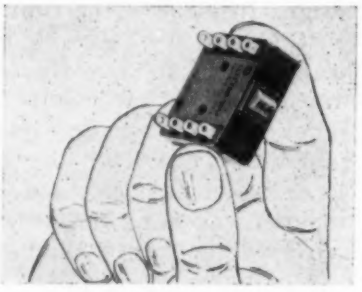
KOBE INC.

Division of Dresser Equipment Co.

Plant: Huntington Park, Calif. — Representatives in CLEVELAND, Pittsburgh, New York, Houston, Oklahoma City.

switch can simultaneously break or reverse current flow through the windings of a three-phase motor.

Operation: Simultaneous switching action permits all four contacts to be wired for use as a single-pole switch on high voltage DC circuits (110 v DC) up to 20 amps. When wired in this manner, arcing will be equally divided between all four contacts, proving how simultaneously the contacts operate. Simultaneous action is independent of the speed of actuation;



both poles will trip at the same time, even when the operating button of the switch is slowly depressed with a micrometer.

Application: Can be used as an inexpensive start-or-stop or limit switch on three-phase machinery and applications where the switch can be used to replace expensive relays or to combine several switching operations into one action.

Dimensions: 1½ x ⅞ x ½ inch; the switch is rated for 15 amps at 125/250v AC and 10 amps at 30v DC.

Electro-Snap Switch and Mfg. Company
Chicago, Illinois

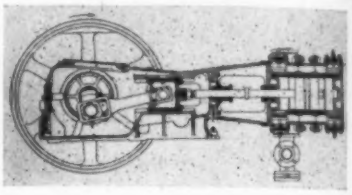
Circle 227 on Reader Service Card

AIR COMPRESSOR
. . . has new design features

Designation: Class ATL and ATCL.

Design: Has steel-backed carbon cylinder-liner and metallic piston rings in the air cylinder. The cylinder has been constructed in segments (Class ATL only) which permits removal for inspection purposes without interrupting the intake or discharge connections.

Features: The absence of lubrication in the air cylinder banished the very real risk of fires and explosion in the machine



proper, the discharge line and in air receivers. Also the compressor valves remain cleaned and efficient which is not always the case when lubricant is involved.

Applications: For use in chemical industries, food processing, breweries and for instrument air.

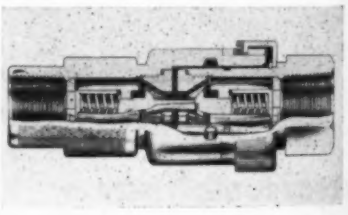
Pennsylvania Pump and Compressor Company
Easton, Pennsylvania

Circle 228 on Reader Service Card

QUICK CONNECT VALVE
. . . for air and oil

Designation: Wave-Flow.

Features: As the two halves of the unit are coupled together, the two piston valves open by moving away from their respective seats. A soft molded insert, mechanically held in place, forms the seat in each half of the coupler. True alignment of pistons



is insured by long guides. Pistons can be readily replaced after long service, if necessary, by unscrewing seat bushings. An O-ring in socket half provides positive seal while coupling is connected. Protector caps are provided for covering coupler halves when disconnected.

Size: Available in ½ inch F.P.T. connections.

Henry Valve Co.
Melrose Park, Illinois

Circle 229 on Reader Service Card

How Do You Buy Bearings?

Do you get a MONEY-BACK GUARANTEE OF LONGER SERVICE AND LOWER MAINTENANCE COST? You do when you buy

PROMET
THE Engineered BRONZE

BEARINGS
BUSHINGS
WEARING PARTS
Machined or rough cast

American Crucible methods, experience, know-how and equipment save you real money. Castings to your patterns—any size, shape or section up to 3,000 lbs. Pattern making, designing and machining.

PROMET
BRONZE BAR STOCK

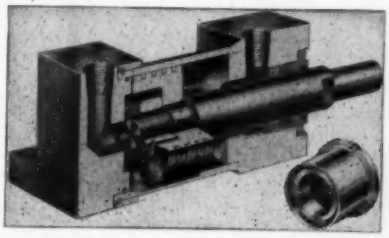
Round, solid, tubular. Rough cast or fully machined. Cored stock, all sizes (by ⅛" steps) from ½" minimum core to 26" O.D. 13" lengths or less. 6 grades of hardness.

Write for literature or send blueprints, conditions of operation and other data for quotations and recommendations as to alloys.

THE AMERICAN CRUCIBLE PRODUCTS CO.
1303 OBERLIN AVE.
LORAIN, OHIO, U.S.A.

HYDRAULIC CYLINDERS . . . have quick change packing cartridge

Features: The cartridge unit can be taken out by simply removing a snap ring. This usually can be done without even dismounting the cylinder. It is then an easy matter to replace the rod



packing or rod wiper. The cartridge is machined from high-leaded bronze alloy, and provides double bearing surfaces of maximum length for the piston rod.

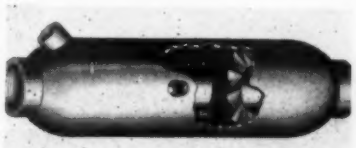
Sizes: This line of 2000 psi hydraulic cylinders includes 11 models in 11 bore sizes from 1½-8 inches.

The S-P Mfg. Co.
Cleveland, Ohio

Circle 230 on Reader Service Card

LINE TYPE PURIFIER . . . for air circuits

Designation: Type LC Hi-eF
Application: Removes entrainment, pipe scale, oil, guck, etc., from air pipe lines and equipment.
Sizes: ½ to 2 inches.
Operation: Removes entrainment by means of a stainless



centrifugal element which engages and imparts a rapid rotational motion to entrainment laden vapor, throwing the solids and water outward to the walls of the purifier; each unit is warranted to remove more than 99 percent of entrainment. Purifiers are installed like valves or steam traps. Other features are no moving parts, minimum pressure drop, lightweight construction, and large entrainment capacity.

The V. D. Anderson Company
Cleveland, Ohio

Circle 231 on Reader Service Card

Custom
HYDRAULIC CYLINDERS

"Husco" builds a complete line of single and double acting cylinders, differential type, as well as telescoping cylinders. All cylinders are built to customer application requirement.

"Husco" cylinders are:

(1) Designed to insure concentricity of guides which are piloted from the same diameter
(2) Adequately guided to prevent any bearing load against the packings—insuring full life of packings and safeguarding against leakage
(3) Provided with an adjust nut for take up on the packings

The line includes pressure actuated reciprocating valves to actuate double acting cylinders, the Series 3000 Control Valves, "the valve with the horshoe ports", relief and flow control valves. Other products available are pumps up to 5 gpm, 1500 psi, and package power units.

"Husco" welcomes the opportunity to provide engineering assistance on hydraulic problems and in developing new equipment.

HUSCO®

Used on: Construction, Industrial Material Handling and Agricultural Equipment

HYDRAULIC UNIT SPECIALTIES CO.
Pumps • Valves • Cylinders
Waukesha, Wis.

USEFUL LITERATURE

You'll find many valuable production and design ideas in publications described here . . . copies will be sent you free without obligation

Continued from page 44

SPIRAL BACK-UP RINGS . . . A 4-page bulletin describing Teflon spiral back-up rings designed for use in conjunction with O-ring seals in hydraulic and pneumatic applications, has been published by Resistoflex Corporation. These rings can be successfully used in hydraulic systems operating above 1500 psi, particularly in temperatures in excess of 250 degrees F. The spiral construction allows expansion of ring for installation, and contraction to original dimensions without distortion. When installed, free ends of ring seat against center ring to form virtually a smooth symmetrical and stable ring. The literature presents dimensional specifications and range of sizes available.

Circle 158 on Reader Service Card

ROTARY PUMPS . . . Geo. D. Roper Corporation has issued an 8-page Catalog 953, covering the 3600 Series, F Series and H Series of their rotary pumps. Each series is described in detail, illustrating construction features and listing sizes, capacities and dimensions. Also included are custom built pumps for a wide variety of applications.

Circle 159 on Reader Service Card

INSTRUMENT MOTORS AND ACCESSORY EQUIPMENT . . . A 20-page illustrated catalog describes a new line of control motors and damped control instrument motors designed and manufactured by Servomechanisms, Inc. These new motors offer the designer various frame sizes, speeds, and input voltages for military and commercial applications. Typical uses include analog computers, aircraft fire control systems, differential analyzers, remote indicating systems, telemetering devices, control of industrial machinery and many other systems in these categories.

Circle 160 on Reader Service Card

TRIPLEX PUMP . . . Two new 90 hp models of triplex pumps of the horizontal plunger type are described in a 4-page folder, Bulletin 401, available from the National Supply Company. The F-90 pump is a 3-cylinder single acting pump with a 5 inch stroke, rated at 90 hydraulic horsepower output at maximum speed of 360 rpm which requires 100 brake horsepower input. All features and specifications are listed and performance charts for both models tabulated. The pump has been developed for water-flooding, salt-water disposal and as a power-oil source for sub-surface hydraulic pumping systems.

Circle 161 on Reader Service Card

ROTARY ABUTMENT UNITS . . . Keelavite catalog, Section B describes the line of fixed and variable capacity pump-motors offered by this company. The principle of two rotating members, one for pumping and one for sealing, was pioneered by Keelavite Rotary Pumps & Motors Ltd., and has been featured for over 16 years. One rotating member, the rotor with two axial blades, is the pumping member; the second rotating member, the rotary abutment, rotates in the opposite direction, maintaining a seal on one side of the annular space between the inlet and outlet ports. Advantages both as pumps and motors, the chief features—precision manufacture, hydraulic balance and full reversibility—are given. Operating and installation notes are included. Plotted curves of typical performance data for three fixed capacity units (No. 202 as pump to 5½ hp at 1500 rpm or motor to 9 hp at 2500 rpm; No. 502 as pump to 25 hp at 1500 rpm or motor to 30 hp at 2500 rpm; No. 1502 as pump to 80 hp at 1500 rpm or motor to 100 hp at 2500 rpm) and one variable capacity unit (No. V548R as pump to 15 hp at 1500 rpm or motor where some extension of speed range with constant hp is required) are shown and typical applications are suggested.

Circle 162 on Reader Service Card

AIR COMPRESSORS . . . Reavell and Company Ltd. have made available a file of catalogs illustrating and describing various types of compressors manufactured by the company. Shown are vertical single-acting single-stage air compressors, hand operated compressors and many others.

Circle 163 on Reader Service Card

PNEUMATIC TOOLS AND EQUIPMENT ... M-B Products has prepared a folder of catalog sheets featuring pneumatic grinders, automatic air line filters and automatic line lubricators. The construction features of all units are described and illustrated and specifications listed. The catalog includes nomographs to assist in the selection of air line filters, lubricators and filter lubricators for a given pressure and desired capacity.

Circle 164 on Reader Service Card

SOCKET-HEAD CAP SCREW ... The Bristol Company, Socket Screw Division has published a bulletin detailing their line of hex socket cap screws. All features and uses of these cap screws which are made in sizes from No. 0 to 1 inch are fully described and specifications given.

Circle 165 on Reader Service Card

SOLENOID VALVES ... Circular VS-50 prepared by the Automatic Switch Co. describes solenoid valves and automatic switches. Shown are packless shut-off needle valves with adjustable flow, packless shutoff valves, safety shut-off valves; also automatic transfer switches and remote control switches, all of which are illustrated.

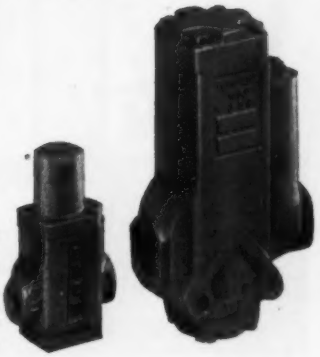
Circle 166 on Reader Service Card

Circle 14 on Reader Service Card

Improve Your Handling Equipment

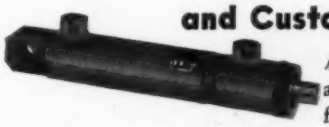
with **BHEW**

HYDRAULIC Flow Control Valves



Increase stability and safety of your lift and straddle trucks. BHEW Flow Control Valves *automatically* control load descent rate at predetermined speed, heavier the load the slower the lowering rate! Eliminate surge at start of descent. No restrictions on load lift speed or empty fork movement. Models for all size trucks, for attachment or O.E.M. applications. Write for detailed, illustrated literature.

and Custom O.E.M. Cylinders



All types and sizes of standard and especially designed cylinders for tilts, hoists, clamps, shifters. Cylinders have small O.D., need minimum mounting clearance. Available for any mounting you desire. Have honed barrels, plated rods, non-adjustable glands. Send specifications of *your* application to

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STOPS

downtime and costly repairs to hydraulic equipment

Honan-Crane

HYDRAULIC OIL PURIFIER

- Removes Solid Abrasive Contamination
- Removes Corrosive Products of Oxidation
- Prevents Sludging
- Keeps Oil CLEAN and SAFE to Use Indefinitely

Sizes for direct connection to individual machines—mobile units for general service.

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OUTSTANDING . . . AND PREFERRED ON ALL INDUSTRIAL HYDRAULICS

. . . Superior Performance
. . . Ease of Assembly
. . . Precision Quality
. . . Large Wrench Flats
. . . Widest Selection of Shapes and Sizes

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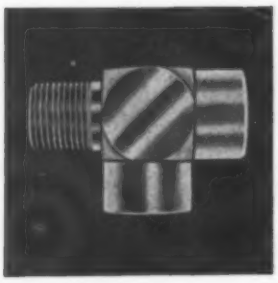
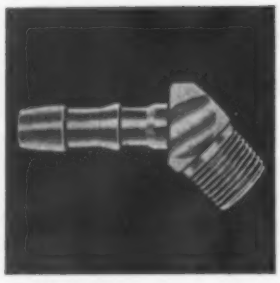
- Two or Three Piece
- Sizes ⅛ to 2" Tube
- Square Stock Bodies
- Variable Length Elbows
- Lateral Tube or Pipe Outlets
- Bulkhead Straights – Elbows



PIPE FITTINGS

- Steel-Bar Stock
- 3000 PSI Service
- Dryseal Pipe Threads
- Elbows, Tees, Crosses, Unions, Bushings, and Nipples



MISCELLANEOUS

- Swivel Elbows
- Restrictor Fittings
- Needle Valves
- Ball Check Valves
- Barbed Hose Stems
- Steel SAE 45° Flare Fittings

Write today for Catalog

Representatives in Principal Cities

L & L MANUFACTURING CO.

Since 1937

8088 EAST NINE MILE RD. • VAN DYKE, MICH.

Circle 60 on Reader Service Card

USEFUL LITERATURE

FLEXIBLE ELECTRICAL WIRING CONDUIT . . . The new flexible liquid-tight conduit, made with a flexible galvanized steel core, positive ground and tough synthetic cover is featured in Bulletin No. UA 530 offered by The American Brass Co. This conduit gives protection against oil, grease, weather, water, dirt, chemicals etc. Can be easily installed and can be adapted to connections between a moving member and a stationary part of machinery. The bulletin shows a cutaway view, typical applications and supplies all specifications.

Circle 167 on Reader Service Card

PIPELINE AFTERCOOLERS . . . A new bulletin published by Kewanee Ross Corporation features the type HCF pipeline aftercooler for air and gas compressors. The features outlined include a non-corroding, copper-brass core assembly, true counter current flow and great heat transfer efficiency. It is designed to cool the air to within ten degrees of inlet water temperature when using 1.5 gpm per 100 cfm of air. Standardized sizes, dimensions and weights are given.

Circle 168 on Reader Service Card

SOCKET SCREWS . . . A 14-page catalog issued by Standard Pressed Steel Co. gives dimensions and specifications of socket head cap screws, socket set screws, self locking socket set screws, flat head socket cap screws, shoulder screws and stripper bolts; also shown are dryseal thread pressure plugs and precision ground dowell pins. using metal tubing or piping, makes a strong leakproof connection and withstands heat and cold extremes.

Circle 169 on Reader Service Card

GASKET MATERIALS . . . An attractive 24-page booklet published by the Armstrong Cork Company, features gasket materials. The first chapter outlines how to choose the right gasket material for a specific application and service. Described are cork compositions, synthetic rubber compounds and others. A chart of gasket recommendations based on either a chemical or mechanical factor is included.

Circle 170 on Reader Service Card

AIR VALVES . . . Developed originally to solve their own valve problems, The Taylor-Winfield Corporation has made available their seal-off valve to users and builders of air operated machines and devices. Catalog 11-213 offered by the company explains the features. The valve has

been designed to give extremely fast, accurate, dependable and trouble-free operation under field conditions. It is of solenoid operated type; all necessary engineering and application data is given and should prove a valuable reference to the engineer's file.

Circle 171 on Reader Service Card

AIR CONTROLS . . . Air control equipment built by Lehigh Foundries, Inc., are described in a condensed catalog. Dimensional and operational information is supplied for speed control valves, 4-way foot, hand, solenoid and cam operated valves; air pressure regulator-filter units; and cylinders. Complete panel control units are also described. Valves are available in ¼, ⅜ and ½ inch pipe sizes.

Circle 172 on Reader Service Card

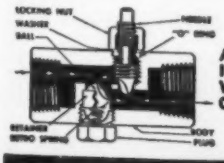
INDUCTION MOTORS . . . The Lima Electric Motor Company has released a new brochure presenting the complete line of drip-proof induction motors. The bulletin includes speed-torque curves, frame number charts, dimensions and specifications for motors from 1/3 to 150 horsepower, as well as complete descriptions for optional mounting and special purpose applications. Also covered are recent changes in design, including use of prelubricated sealed ball bearings.

Circle 173 on Reader Service Card

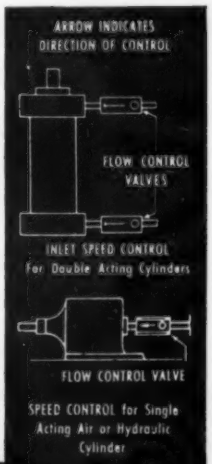
Get Easier, More Accurate Cylinder Speed Control

with **Pneu-Trol VALVES IN AIR OR HYDRAULIC USE**

Pneu-Trol Valves combine in a short, compact body, a tapered fine thread needle for extremely accurate air or oil flow control and a floating retro ball check, which permits full flow in the opposite direction. Improved "O" Gland structure seals and locks the fine needle setting when speed adjustments are made. Retro ball floats in most sensitive position to seat, requiring only a slight differential pressure to fully open or close it. Pneu-Trol Flow Valves are available in 5 female pipe sizes — ⅛" to ¾". Valve bodies are made from brass, aluminum, steel or stainless steel.

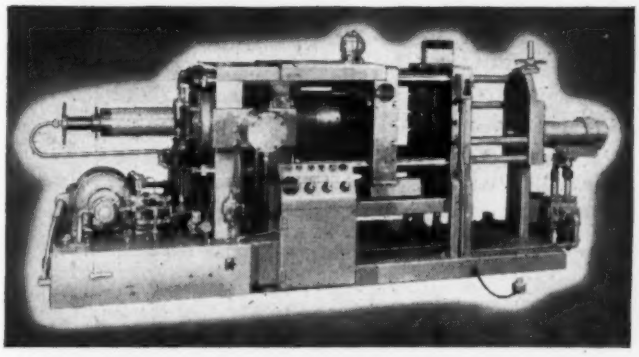


Attractive Prices — Immediate Delivery Write for Illustrated Circular and Price List.


ARROW INDICATES DIRECTION OF CONTROL
FLOW CONTROL VALVES
INLET SPEED CONTROL for Double Acting Cylinders
FLOW CONTROL VALVE
SPEED CONTROL for Single Acting Air or Hydraulic Cylinder

Pneu-Trol Devices, Inc.
1426 N. Keating Ave., Chicago 51, Ill.

HOW PALMETTO G-T RING "showed" CUYAHOGA INDUSTRIES its superiority in PACKING PERFORMANCE

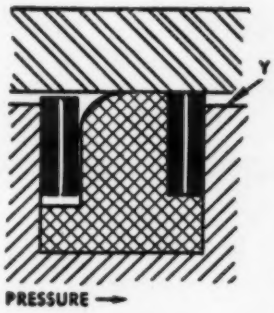


This Ohio firm was "from Missouri" where packing was concerned

At Cuyahoga Industries in Cleveland, Ohio, the Palmetto G-T Ring and a conventional packing were matched for performance in a Cuyahoga-made 600 ton Wedgelock Die Casting Machine. Results: The conventional packing with leather back-up rings extruded and had to be replaced within three months. Palmetto G-T Ring performed satisfactorily without replacement for over a year! When it's getting too tough for other packings, it's "just right" for G-T Ring.

THE KEY TO LONG SERVICE UNDER PRESSURE IS NON-EXTRUSION . . . *THE KEY TO NON-EXTRUSION IS THE*

PALMETTO® G-T RING



As pressure is applied, conventional packings soon extrude into clearance space Y, then fail. Not so the G-T Ring! Because of its design consisting of a resilient sealing ring in a T-Section supported on each side by two non-extrusion rings, it cannot extrude. As pressure is applied to the G-T Ring, the resilient material flows under the non-extrusion rings, urging them against the cylinder wall and blocking the path of extrusion.

Interesting?

OUR 90th YEAR NEARLY A CENTURY OF Quality

Write for your complimentary copy of the new Greene, Tweed manual. This helpful 32-page handbook for the design engineer covers Palmetto G-T Packings in detail—as well as other noteworthy Palmetto Molded Packings.

packing more performance into every application PALMETTO Packings

GREENE, TWEED & CO. North Wales, Pa.

Circle 76 on Reader Service Card

Circle 40 on Reader Service Card

USEFUL LITERATURE

SMALL INDUSTRIAL PUMPS . . . Tuthill Pump Company features the model L series of small industrial pumps in Catalog No. 101. This pump is a compact, highly efficient positive displacement, internal gear rotary pump with mechanical seal. Built in 5 sizes, it provides capacities from 20 to 360 gallons per hour and pressures up to 600 psi. It is directional in rotation and designed for direct drive at standard motor speeds. This well illustrated booklet shows dimension diagrams and a parts diagram with a parts list tabulated for ready reference. Also illustrated are the various types of mounting feet optional with the model L series of pumps. Characteristic performance charts are included.

Circle 174 on Reader Service Card

FLEXIBLE METAL HOSE . . . Universal Metal Hose Company has issued a complete data book, describing application, temperature ranges of various types of metal and wire braided hose, couplings and assemblies. Types illustrated include seamless all-metal flexible pressure hose, interlocked suction, blower and conveyor hose, high pressure hydraulic hose and others for special applications. The booklet illustrates the various types of products, giving dimensions and construction data.

Circle 175 on Reader Service Card

SCALE DRAWINGS OF GEARMOTORS . . . U. S. Electrical Motors, Inc., offer scale drawings of the Syncrogear line to layout draftsmen, designers and engineers. Drawn in simplified style, but to exact scale, these drawings are designed to be inserted under a layout of a machine or other equipment and traced in the proper size and position. Three views are included of each of the 30 various motors shown. Single and double reduction Syncrogears as well as the worm type Syncrogear have been scaled for tracing. A booklet containing specifications will be supplied with the scale drawings.

Circle 176 on Reader Service Card

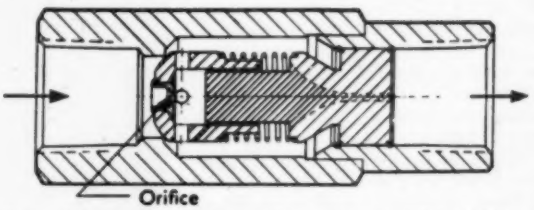
OIL AND GREASE SEALS . . . The Garlock Packing Company has published an attractive 100-page Catalog on Klozure oil and grease seals for bearings and mechanical seals for rotary shafts. A very handy illustrated index gives an overall picture of Klozure model numbers, its maximum sealing surface speeds, temperature, sizes furnished, and then refers to the pages where the individual models are fully detailed. The sealing element is made of a synthetic ma-

RESTRICTOR VALVES
Non-Adjustable

■ ECONOMICAL
■ RELIABLE
■ ORIFICE SIZE TO SUIT YOUR APPLICATION

Write for engineering data and specifications.

- For oil or gasoline
- ¼", ⅜", ½" and ¾" pipe size
- Copper-brazed steel or aluminum bodies
- To 3000 P.S.I. service



Free flow in direction of arrow, restricted flow in opposite direction. Please specify desired flow and pressure.

Manufacturers of Hydraulic Valves and Devices
Relief Valves • Check Valves • Restrictor Valves • Needle Valves • Pilot Check Valves • Clamping Valves • Small Spring Loaded Accumulators • Special Valves

Fluid Controls, inc.

1284 N. CENTER STREET MENTOR, OHIO

terial, molded in precision molds to extremely accurate dimensions. General engineering data, installation instructions and typical applications are outlined.

Circle 177 on Reader Service Card

RUBBER INJECTION MOLDING . . . A folder offered by Minnesota Rubber & Gasket Co. describes a process of injection molding which entirely eliminates flash. This process permits the formation of rubber parts to extremely close tolerances, uniform rubber density, and avoidance of trimming blemishes. This process is successfully used in the production of O-rings, pump impellers, bushings and many other parts to be used in hydraulic machinery, pneumatic devices, lubrication and automotive equipment.

Circle 178 on Reader Service Card

LABORATORY FILTER . . . A brochure by Micro Metallic Corp. describes the porous stainless steel filter. This filter was developed to provide unbreakable, chemically resistant laboratory filters. The porous metal filter material is made by newly developed powder metallurgy methods from pre-alloyed stainless steel powder. The brochure shows available forms of filters and gives specifications.

Circle 179 on Reader Service Card

UNBRAKO®

dryseal-thread

PRESSURE PLUGS

seal tight

without compound

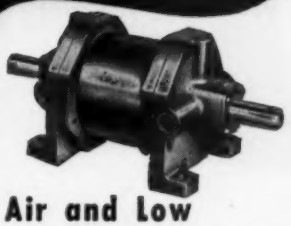
When UNBRAKO Pressure Plugs are tightened, major and minor diameters are positively sealed, pressure tight without sealing compound. UNBRAKO Dryseal-Thread Pressure Plugs, in a full range of sizes from ⅛" to 1¼" NPTF, are available from your local UNBRAKO distributor's stocks. Write for literature. SPS, Jenkintown 2, Pa.

Our Fiftieth Year : A START FOR THE FUTURE

UNBRAKO SOCKET SCREW DIVISION SPS JENKINTOWN PENNSYLVANIA

Circle 52 on Reader Service Card

GET THESE FEATURES IN ALL YOUR FUTURE CYLINDERS



Hydraulic High Pressure

- ★ Centrifugally Cast Cylinder Bodies
- ★ Cast Steel or Semi-Steel End Caps
- ★ Cast Iron Piston with Automotive Type Rings
- ★ Leakproof Packing. "O" Rings in each end cap
- ★ Adjustable Port Location
- ★ Fixed Cushions Standard Construction — Adjustable Cushions Optional

Air and Low Pressure Hydraulic

- ★ Compact — No Tie Rods
- ★ Extra heavy walls of selected tubing
- ★ Metal to metal assembly preloads piston cups
- ★ Automatic rod packing requires no take-up. Seals under pressure
- ★ Aluminum alloy piston with steel cup retainer
- ★ Extra long rod guide

HYDRO-LINE CYLINDERS CONFORM TO J. I. C. STANDARDS

➡ ***FREE Additional Data***

covering additional construction and performance features are included in this catalog. Write for your copy today. Ask for bulletin 350.

Hydro-Line

HYDRO-LINE MFG. CO.
705 19th Street
ROCKFORD, ILLINOIS

What's Your Hydraulic Line Problem? There's an answer in the ONLY COMPLETE SELECTION

ULRIX offers a model and size for any problem — standard and break-a-way types. ULRIX QUICK COUPLERS connect under pressure without tools. WRITE for FULL DETAILS.

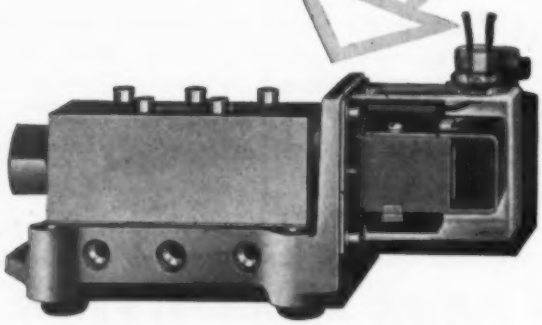
ULRIX

QUICK COUPLERS
For All Hydraulic Lines

ULRICH MFG. CO. ROANOKE, ILL.

Quick-As-Wink
AIR AND HYDRAULIC
Control Valves

FEATURE THIS MONTH

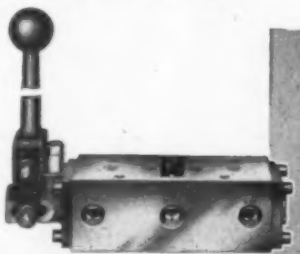


1/8" and 1/4" Single Solenoid Valves

They'll give you up to 300 cycles a minute
For air to 125 psi—vacuum—
or low pressure hydraulic service

● These valves combine the utmost simplicity in design with rugged construction. They will give you millions of cycles of highly satisfactory, efficient, trouble-free service. Small solenoid, with short stroke operates the valve plunger, eliminating levers, links and pins. Low amperage requirement eliminates intermediate relays and simplifies electrical control circuits. Side or bottom pipe connections. Valve body and solenoid are both mounted on an aluminum base and can be removed independently without disturbing the piping. 2, 3, 4 and 5-way actions. *Write for full details today!*

also the following

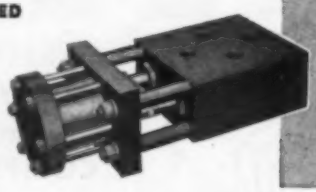


LEVER OPERATED SINGLE PLUNGER VALVES

Two position and three position valves, 3/8" to 1 1/2" sizes; 2-way, 3-way and 4-way actions. Widely used for controlling the operation of single and double acting cylinders or as pilots for operating other valves.

PILOT CYLINDER OPERATED HYDRAULIC VALVES

Two position valves, 1/2" to 4" sizes, for line pressures from 1000 to 5000 psi. Valve is placed close to the work and operated from a central control point with an easy to handle air valve avoiding operator fatigue.



For Fully Descriptive Data Sheets Write

C. B. HUNT & SON, Inc.

Hand, Foot, Lever, Cam, Pilot, Diaphragm and Solenoid Control Valves

1991 EAST PERSHING STREET • SALEM, OHIO

USEFUL LITERATURE

SEPARATORS AND DRAINS . . . Designed to remove dirt and water from compressed air systems, these devices are detailed in Catalog 512, which is offered by Wilkerson Corporation. Size, construction and operating data is supplied for air compressor receiver drain valves, air governors and governor filters, diaphragm operated valves, float operated valves, float operated sump drains, and manually operated separators and drains. Cross-sectional drawings are provided to assist in understanding the operation, installation and care of these components as they are applied to keep air systems free of dirt and water.

Circle 180 on Reader Service Card

OIL HYDRAULIC EQUIPMENT . . . A new illustrated catalog covering the most complete line of oil hydraulic equipment for mobile applications has been released by Vickers Incorporated. Catalog M-1501 provides latest specification and engineering information on hydraulic vane type pumps and motors, valves, power steering pumps and steering boosters, and other oil hydraulic units specifically designed for equipment in the automotive, materials handling, construction machinery, agricultural and mining industries.

Circle 181 on Reader Service Card

Solenoid Pilot Air Valves . . . Folder P issued by Valvair Corporation describes the Valvair line of solenoid pilot valves for operation on fluid systems to 125 psi. The folder includes line drawings for 2-, 3- and 4-way valves. Data on construction and solenoid ratings is tabulated.

Circle 182 on Reader Service Card

OIL FILTERS . . . Used on the intake to air compressors, these oil bath type air filters are described in a catalog available from Air-Maze Corp. Performance data indicates efficiencies to 98 percent and very low resistance to air flow. Simplicity of filter element removal is illustrated along with operation and construction details. Sizes with and without built-in relief valves are tabulated, and selection charts help to determine the correct size for each application.

Circle 183 on Reader Service Card

CONTROL VALVE . . . The Annin Company has issued a 4-page bulletin which features valves with a Teflon guide bushing. These valves feature full floating operation, free from any metal to metal contact in moving parts. Teflon eliminates valve stem galling, it is self lubricating and requires no external lubrication; it has the strength to withstand high pressures and is unaffected by the most corrosive acids. An engineering drawing illustrates the valve, showing the full floating Teflon guide bushing contact.

Circle 184 on Reader Service Card

PUMPS, MOTORS, TRANSMISSIONS . . . Berry Division of Oliver Iron and Steel Corporation has prepared an 8-page Catalog 5209 which clearly shows the operation of their unique rotary positive displacement pumps and motors. Exploded views show the construction, photographs illustrate actual applications and circuit drawings show the use of these units on variable speed drives, for braking, as flow dividers and in series-parallel hook up. Motor and pump selector charts will assist you in choosing pumps rated from 9.2 to 228 gpm and motors having a torque rating 32 lb-ins per 100 psi to 1200 lb-ins per 100 psi.

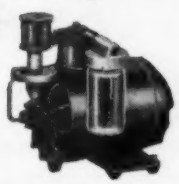
Circle 185 on Reader Service Card

HYDRAULIC QUICK COUPLERS . . . Pioneer Hydraulics, Inc., has issued a data sheet illustrating and describing two new models of quick connect and disconnect hydraulic couplers for farm tractors and industrial hydraulic systems. Both models 4000 and 5000 are made for ⅜, ½ and ¾ inch hose, provide positive flow or shut off and are guaranteed not to leak. Pioneer couplings are of rugged construction for extreme pressures, both models will operate at pressures up to 6000 psi, yet are light in weight, easy and fast in operation. The couplings are equipped with the finest steel ballchecks for positive sealing, maximum flow and long life. Both couplings may be used as a break-away coupler when installed in the Pioneer Break-away Clamp.

Circle 186 on Reader Service Card

two handy packages-- these GAST rotary-vane INTEGRAL-MOTOR AIR PUMPS

Standard Model 0210, ¼ H.P., 1.3 C.F.M. to 25 P.S.I. or 27" vacuum. Oil-less Model, to 10 P.S.I. or 15" vacuum.



Model 0320, ⅓ H.P., 2.5 C.F.M., to 25 P.S.I. or 28" vacuum.

You can solve many an air-pump requirement—vacuum or pressure—with one of these "handy packages." For Gast *integral-motor* Air Pumps are widely used as original equipment by engineers who require smooth, dependable performance in a compact, space-saving unit.

The smaller Model 0210, a highly popular unit, supplies vacuum for engraver's printing frames, feeding devices, laboratory use, etc., in either lubricated or oil-less models.

For vacuum to 28" in low volume applications, Model 0320 is used for production line testing for leaks, for punch press feeding devices, etc. There are scores of uses for these "packaged" integral-motor pumps.

see our catalog in S PRODUCT DESIGN FILE or write for copy

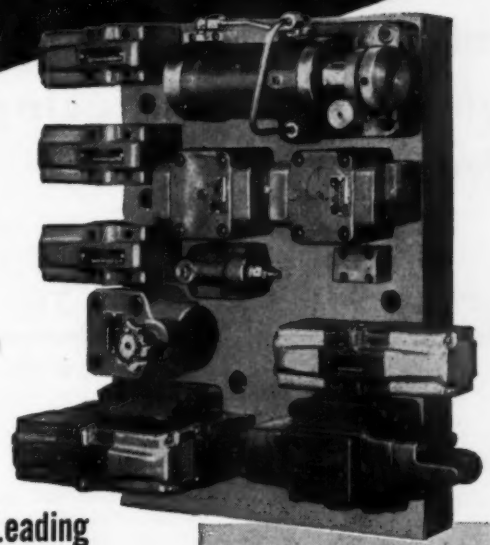
Write for Catalog and Application-Ideas Booklet!

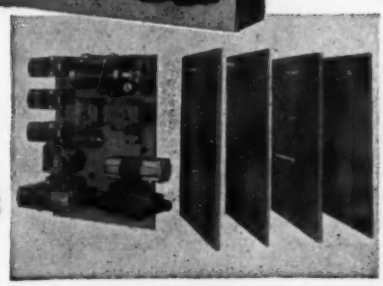
Original Equipment Manufacturers for Over 25 Years

GAST ROTARY AIR MOTORS · COMPRESSORS · VACUUM PUMPS (TO THREE H.P.) (TO 30 LBS.) (TO 28 INCHES)

GAST MANUFACTURING CORP., 831 Hinkley St., Benton Harbor, Mich.

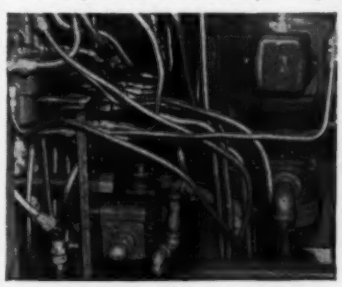
ENGINEER *Simplicity* INTO YOUR HYDRAULIC EQUIPMENT CONTROL SYSTEMS





Leading Hydraulic Manufacturers Are Using Almo Manifolds to Cut Costs and Obtain Permanent Trouble-Free Operation

Almo has perfected the manifold method of channelling hydraulic fluids at high pressures after years of research and can apply it to your equipment. Send a diagram of one of your present hydraulic circuits. Without obligation we will return an Almo Manifold diagram demonstrating how the job can be completely simplified.



This maze of piping and tubing, all subject to failure resulting from vibration and deterioration, can be eliminated and made as compact and simple as the unit illustrated above.

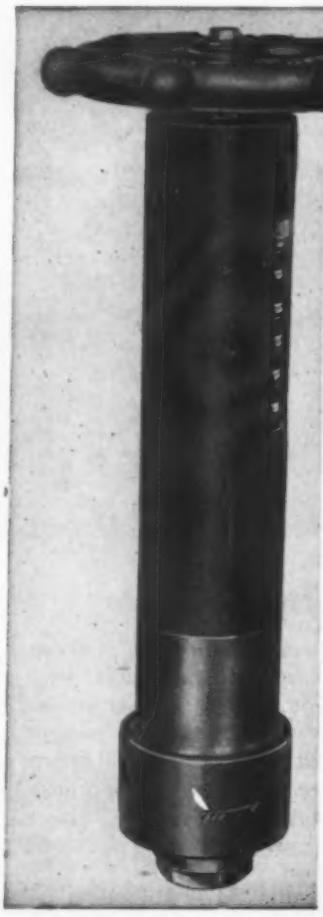
Write for our new brochure

ALMO TOOL CO.

3327 E. VERNOR • DETROIT 7, MICH.

ATLAS

It handles pressures up to 6,000 lb. per sq. in. without shock—OIL, AIR, or WATER. It is called the "ATLAS Type E High Pressure Reducing Valve."



This is it.

STELLITED

Those internal parts that must endure severe corrosion and abrasion are STELLITED—the seat ring and the main valve. Other internal parts are hard chromium plated stainless steel. Spring loaded. Piston balanced. Self-contained. Reduces highest initial pressures down to as low as 100 lb. per sq. in. Holds set pressure closely in spite of changes on inlet side. Does not leak on tight shut-off. Excellent for hydraulic presses. Also available as high pressure relief valve.

Ask for Data

If you have other regulating problems our engineers will gladly work with you on them. ATLAS has been in the regulating business, exclusively, for more than a half century. See list of other ATLAS products below.

ATLAS VALVE COMPANY

REGULATING VALVES FOR EVERY SERVICE

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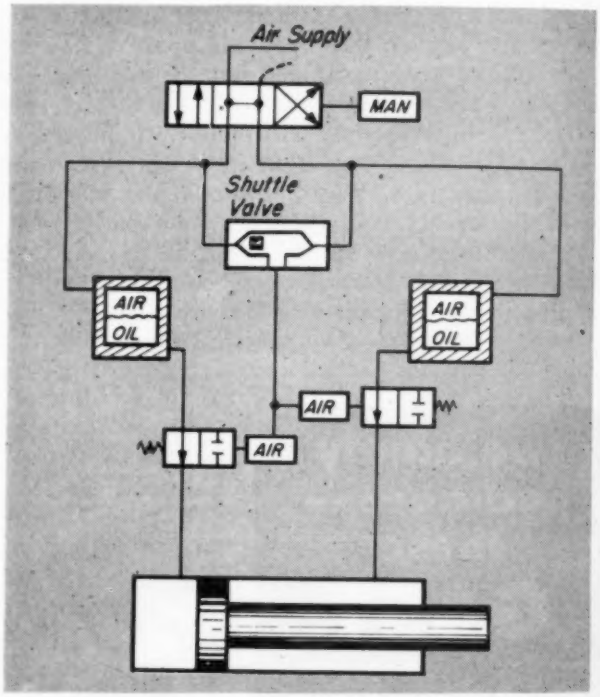
Campbell Boiler Feed Regulator
Temperature Regulators
Reducing Valves
Exhaust Control System
Pressure Regulators
Pump Governors
Damper Regulators
Back Pressure Valves
Balanced Valves
Control Valves
Float Valves

Here's an Air-Oil Circuit . . . for locking a piston

THIS is the problem: The table of the machine is moved by a cylinder having a five foot stroke. An operator must be able to stop the piston travel at any point in the stroke. He can do this visually. Stopping the piston need only be done within an accuracy of two inches and since the piston is moving at a slow rate of two feet per minute, the operator's response to a visual mark is good enough. The equipment is only used several times a day so it is desirable to avoid the cost of electrical controls.

Here's the circuit Clete Tepas quickly sketched for us to meet the requirements of the job. Clete is the



Miller Motor representative in the Buffalo area and he's partial to air powered-oil controlled circuits. They have their advantages cost-wise and if your power and cycling requirements can be met these circuits will result in considerable savings.

Clete's circuit uses a 4-way open center air valve, a double check shuttle valve and a couple air operated 2-way valves. When the manual valve is shifted to either working position, pilot air holds the 2-way valves open. To stop the cylinders, the operator shifts the 4-way valve to neutral. Pilot air is released from the 2-way valves and the springs snap them to the closed position trapping oil on both sides of the piston head. This action locks the piston between fixed columns of oil. The job couldn't be done with air alone because of its compressibility. Sure, it could be done with an oil circuit — for a lot more dollars.

What do you think of this circuit? If you have other circuit ideas to solve this or a similar job, jot them down and send them to us.

National Conference On Industrial Hydraulics
Technical Program for Oct. 8-9 Meetings

JOHN G. DUBA, Secretary, National Conference on Industrial Hydraulics, has issued a preliminary technical program of the Ninth Annual Meeting which will be held at Hotel Sheraton, Chicago, on Thursday and Friday, October 8 and 9. As in the past a general session will be held the first morning and group meetings will be held the afternoon of the first day and both morning and afternoon of the second day. Two new sessions, Components and Industrial Nonflammable Fluids will be held, making a total of nine group sessions.

General Session

Philip H. Emerich, Manager, Product Service Department, Vickers, Inc. will act as chairman of the general session at which W. P. Green, Manager, Heat Power Research Department, Armour Research Foundation, will speak on "Fluid Friction and Wear Phenomena".

Automotive Papers

Two papers will be given at the Automotive Session. R. R. Peterson, Chief of Suspension Laboratory, Chrysler Corporation, will speak on "Hydraulics Applied to the Automotive Suspension" and C. L. Kalitta, Chief Engineer, Warner Division, Detroit Harvester Co., will read a paper on "Hydraulic Mechanisms for Operating Auto-Window Lifts, Convertible Tops, Seat Adjustment, Windshield Wipers, etc." Joseph Geschelin, Detroit Editor, Automotive Industries will chairman this session.

Heavy Presses

Robert G. Tabors, Manager, Hydraulic Press and Power Tool Department, Baldwin-Lima-Hamilton Corp. will act as chairman of the Presses Session. E. V. Crane, Chief, Special Development Engineering and W. R. Jackson, E. W. Bliss Co., will present their paper "Hydraulic Problems of Large Forging Presses" and A. J. deMatteo, Chief Engineer, Watson-Stillman Co., will offer his paper "Self Contained Pump Units as Applied to Extrusion Presses" at this session.

The Pumps Session will hear O. M. Kristy, Engineer, Centrifugal Pump Division, Allis-Chalmers Mfg.

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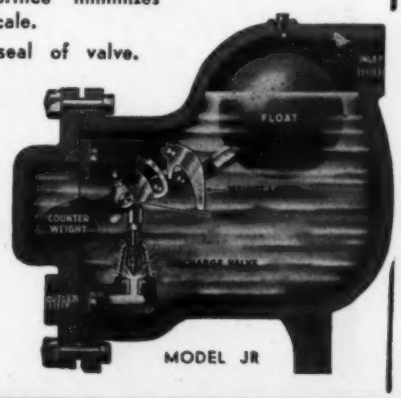

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NCIH October Meeting

Continued

Co., on "Boiler Feed Pumps" and H. Stern and W. T. Rauch, Development Engineers, General Electric Co., on "Ball Piston Pumps and Motors".

Aircraft Pump Design

The program for the Aircraft Session is still incomplete. The one paper that can be announced is "Aircraft Variable Delivery High Pressure Fuel Plunger Pump" by John Pelz, Bendix Products Division, Bendix Aviation Corp. The other paper and the name of the chairman will be announced later.

Both papers have been announced for the Machine Tool Session. Ransom Tyler, Designer, The Oilgear Company, will speak on "Hydraulic Applications in Paper and Paper Processing". G. F. Warnke, Supervisor, Control Systems, Electrical Engineering and S. Hori, Electrical Engineer, Armour Research Foundation, will present their paper "Hydraulically Operated Test Table with Three Degrees of Freedom". The chairman will be announced later.

L. Pfost, Chief Engineer, Tractor Division, Massey-Harris Co., will act as chairman of the Tractors Session. Harold L. Brock, Chief Engineer, Tractor Engineering Department, Ford Motor Co. will be heard on "Hydraulic Systems of the Golden Jubilee Ford Tractor" and W. W. Henning, Divisional Chief Engineer, Advanced Engineering, International Harvester Co., will read his paper "Hydraulic Actuation of the TD-24".

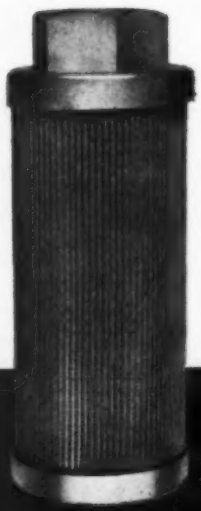
Instrumentation

Two papers have been announced for the Instrumentation Session. R. E. Boyar, Development Engineer, Askania Regulator Co., will speak on "Pressure Transducers". Dr. Yao Tzu Li, Research Associate, and Philip A. Lapp, Department of Aeronautical Engineering, Massachusetts Institute of Technology, will present their paper "A Flowmeter for Measuring Mass Flow-Rate with a High Speed of Response".

Tubing and Packings

At the Components Session, the first to be held at a NCIH meeting, John Jass, Chief Engineer, Caterpillar Tractor Co., will give a paper on "Fluid Carriers for Hydraulic Units in Earth Moving Equipment" and Justus B. Stevens, Jr., Vice President and Chief Engineer, and Harold F. Greiner, Project Engineer, Sealol Corporation, will present their paper, "Factors in Design of Mechanical Seals and Applications to Hydraulic Equipment". R. O. Isenbarger, Chief Engineer, Chicago Rawhide Manufacturing Co. will act as chairman of the Components Session.

The other new sectional meeting, the Industrial Non-Flammable Fluids



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Session, will be under the chairmanship of J. C. Van Gundy, Technical and Research Division, The Texas Company. This session will hear D. Milne, Supervisor, Materials and Processes, General Motors Corp., on "Industrial Application of Non-Flammable Hydraulic Fluids" and James Robinson, Chief Engineer, Vickers, Inc., on "The Effects of Synthetic Fluids on Hydraulic Components and Circuits".

Since the NCIH meetings have attracted an increased attendance each year, the Director for the Ninth Meeting, O. E. Teichman, Assistant Chairman, Heat Power Research Dept., Armour Research Foundation, advises that advance reservations will be accepted and suggests that hotel reservations also be made early.

Executive Committee Appointments

O. E. Teichman, Director of the Ninth Annual Meeting, NCIH, announces seven new appointments to the Executive Committee. Four industry members include: J. F. Ziskal, Chief Engineer, Farm Tractor Division, International Harvester Co.; Ernst Wiedmann, Chief Engineer, The Oilgear Co.; W. W. Weltmer, Hydraulic Engineer, Allis-Chalmers Mfg. Co.; and R. O. Isenbarger, Chief Engineer, Chicago Rawhide Mfg. Co. The three new university members are: V. L. Streeter, Director, Fundamental Fluids Research, Illinois Institute of Technology; W. S. Hamilton, Associate Professor, Department of Civil Engineering, Northwestern University; and R. E. Peck, Professor, Department of Chemical Engineering, Illinois Institute of Technology.

Carl E. Schmitz, Vice President, Crane Packing Co., has been appointed as Associate Director and John G. Duba, Assistant Professor, Department of Civil Engineering, Illinois Institute of Technology will again act as secretary.

To register for the 9th NCIH meetings . . .

request blanks from John G. Duba, Conference Secretary, National Conference on Industrial Hydraulics, Illinois Institute of Technology, Technology Center, Chicago 18, Illinois.

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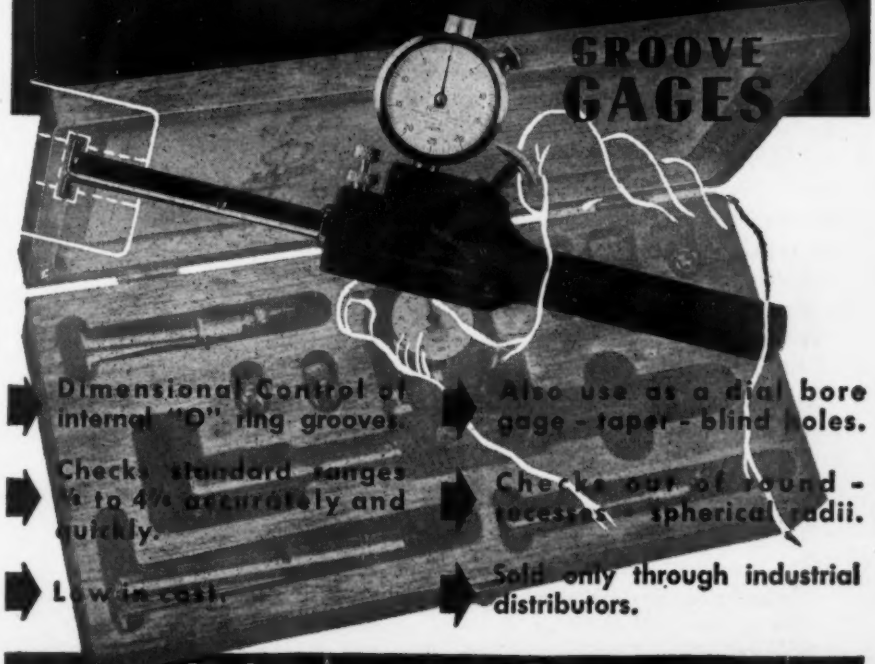

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Hydraulic Flow Control Circuits

Choice of Circuits

Speed of any hydraulic motor, whether it's a linear cylinder or rotary fluid motor, is determined by the rate at which oil is pumped into the hydraulic motor. Most present day applications of hydraulics require controlled movement of the motor. Production economies call for rapid forward and retraction strokes and controlled feeds during the work stroke. This may be on a drilling, milling or similar tool or work feed job.

Presented here are basic methods of controlling feed by varying oil flow with volume control valves. These circuits use constant displacement pumps which deliver a fixed volume of oil to the circuit.

Each control method has its advantages and limitations; therefore, the requirements of each machine should be analyzed to select the circuit which is best suited.

Simple Orifice Circuit

The simplest method of metering flow is to create a restriction in the fluid carrying line. This can be done by introducing a fixed orifice or by using an adjustable needle valve. Here's what happens in the circuit shown in Figure 1. The job calls for a feed rate of 60 ipm and there is a constant load which requires 80 psi acting on the head end of the cylinder. On this circuit, we'll set the relief valve at 1000 psi. Because the orifice is a restriction, which permits only a fixed rate of oil flow to the cylinder, the amount of pump capacity which exceeds the flow passing through the orifice must dump off the relief valve.

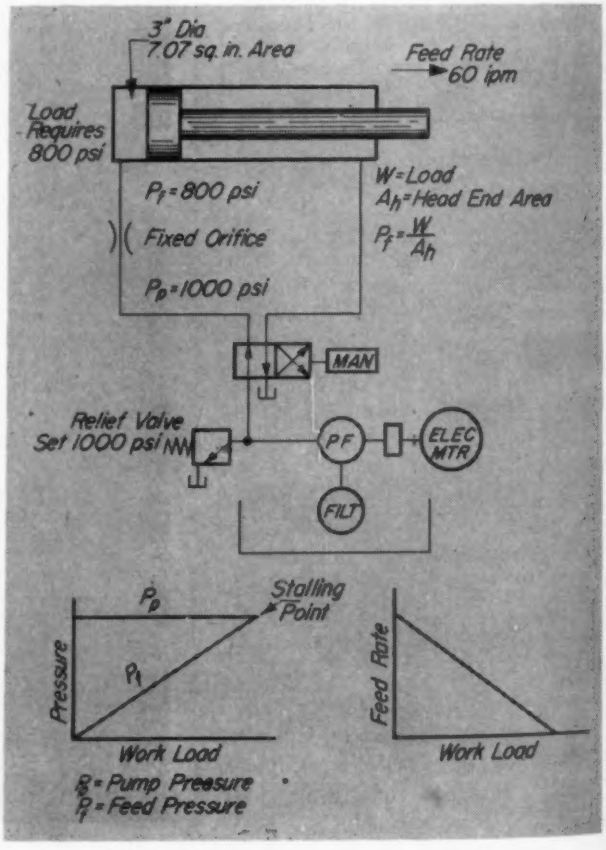
Here is how to determine an orifice size which will give the desired piston speed under these given conditions:

1. Pressure drop across the orifice for this load is:
$$1000 - 800 = 200 \text{ psi.}$$

2. A constant oil viscosity and operating temperature must be assumed. Any variation will change the flow through the orifice. We'll select an oil having a viscosity of 150 SSU at 100 F.

3. Required rate of flow through the orifice:
$$Q = RA = \frac{60 \times 7.07}{231} = 1.84 \text{ gpm}$$

4. Area of the orifice is a function of oil flow and pressure



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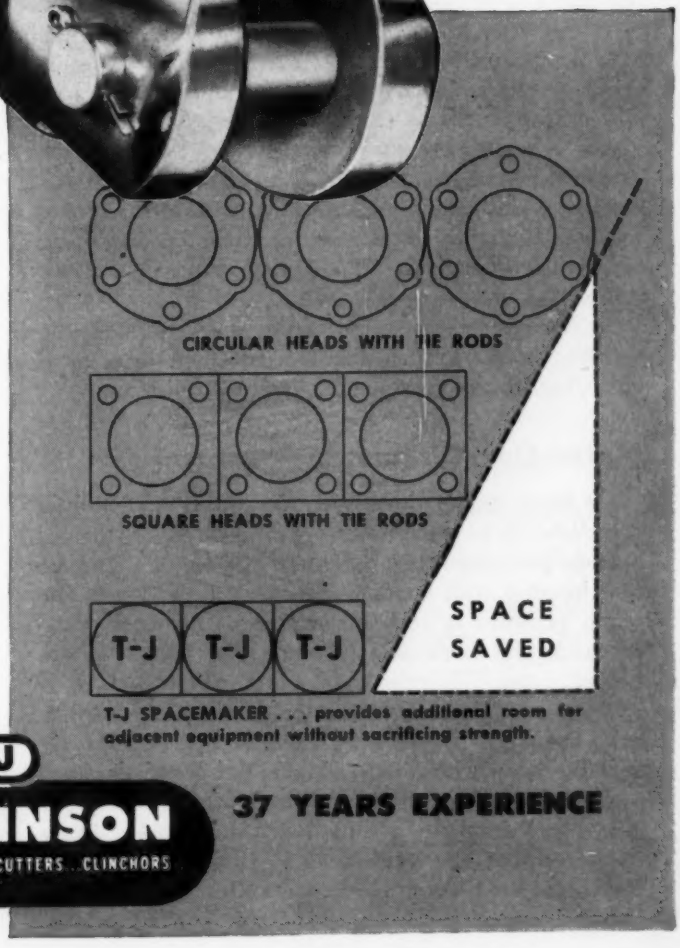

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drop which are known. It is also a function of some variables which involve orifice shape and oil viscosity.

$$\text{Area} = K\left(\frac{Q}{\sqrt{\Delta P}}\right)$$

where Q = flow rate, Δ p = pressure drop and for our problem K = .0325 which takes care of variable coefficients and dimensional constants to arrive at an answer in square inches.

$$\text{Area} = \frac{.0325\ Q}{\sqrt{\Delta p}} = \frac{.0325 \times .184}{\sqrt{200}} = .00423 \text{ sq. in.}$$

Diameter of orifice = .073 inches

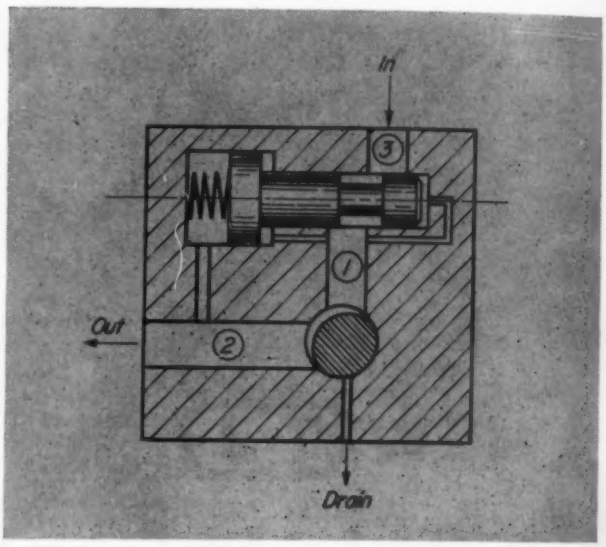
This arrangement, Figure 1, has some obvious limitations. If the load varies, the pressure drop across the fixed orifice will change and consequently the feed rate will vary. Also since the pump is operating continuously at maximum pressure, the efficiency is low. The curves in Figure 1 show these characteristics.

Pressure Compensated Flow Control Valve

To overcome the condition of varying feed rates with varying loads which exists when a simple orifice is used, the pressure compensated flow control valve has been developed. A schematic of this valve is shown in Figure 2. This valve combines an orifice which is a slot cut in a metering shaft and a pressure compensating spool. The pressure compensator functions as a pressure reducing valve to maintain a constant pressure drop across the metering orifice regardless of load.

This constant pressure drop across the metering orifice, about 50 psi, is equal to the spring tension behind the compensator spool. The schematic clearly shows that for the spool to be in balance and at rest the pressure at 1 must be greater than the pressure at 2 by an amount equal to the spring tension. Suppose the load drops and pressure at 2 drops, the compensator spool will momentarily be unbalanced and the spool will shift to the left reducing the opening at 3, thereby giving a greater pressure drop across 3 to reduce the pressure in 1 and put the spool in balance. The pressure drop between 1 and 2 remains equal to the spring tension. While there is a small variation in spring tension for different positions of the compensator spool, this variation is insignificant.

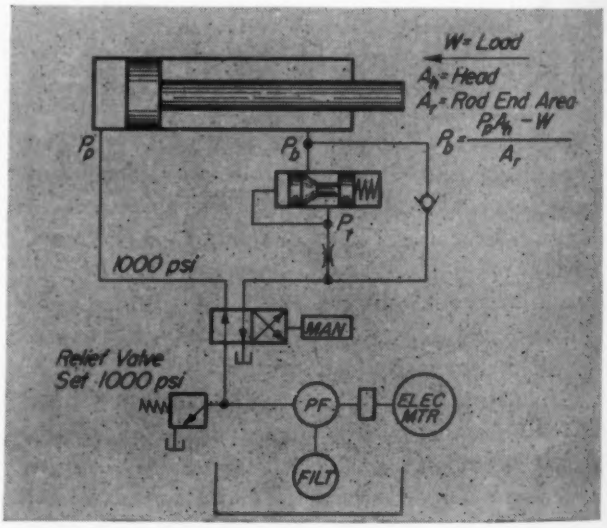
By changing the position of the metering shaft, the rate of flow can be varied from a minimum of about 5 cu in/min to the maximum capacity of the valve.



Meter-Out Circuit

On many applications, such as drilling and milling it is desirable to use a meter-out circuit which provides a back pressure. This back pressure helps minimize tool lunging with sudden release of work load. The pump pressure is constant regardless of work resistance. As the work load increases, the back pressure drops.

With a single acting cylinder as shown in the circuit, the back pressure P_b exceeds the pump pressure P_p at low work loads. The load at which the back pressure starts to fall below pump pressure is determined by the ratio of head and rod areas and is easily computed from the formula for P_b shown on the drawing. This intensified pressure can reduce the life of the rod packings.



Efficiency of this circuit is low because the pump is always working at peak pressure. However, the advantage of supporting a negative work load has been obtained. Feed rate remains constant as long as the back pressure exceeds the setting of the compensator in the flow control valve.

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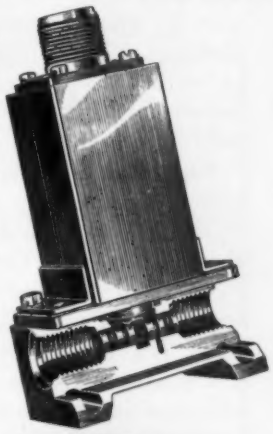

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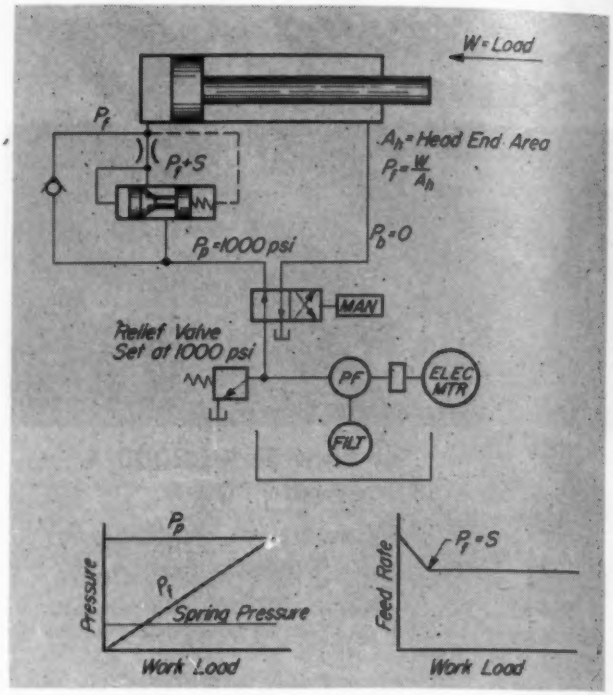
Flow Control Circuits

Meter-In Circuit

Placing the flow control valve in the head end line, as shown in Figure 3, results in a meter-in circuit. The pressure compensated valve is schematically shown as a reducing valve spool and an orifice. The pump operates continuously at the pressure setting of the relief valve as excess oil goes to tank through the relief valve. Comparing the characteristics of this circuit to those of the simple orifice circuit, you will note that the rate is now constant with varying load. Efficiency has not been improved.

Supposing S, the spring force has a mean value to give a pressure drop across the orifice of 50 psi, and P_p is 1000 psi at all times. If the work load requires a P_t of 800 psi, the compensator shifts to give $P_p - (P_t + S) = 150$ psi drop. If the load drops and requires only 500 psi, the compensator closes to give $P_p - (P_t + S) = 450$ psi drop.

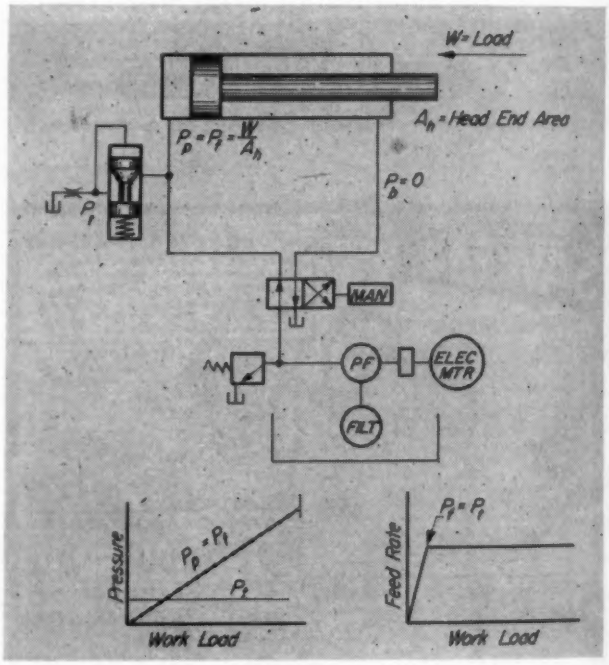
The curves shown with the meter-in valve circuit tell what happens to the pressures and feed rate with varying load. Because this circuit does not have any back pressure in the rod end line it is not applicable on jobs where some negative work load must be supported.



Bleed-Off Circuit

Efficiency of operation is improved by use of the bleed-off circuit shown in Figure 5. Pump pressure varies with work load, excess oil is metered off to tank through the bleed off valve. There is no throttling loss on the fluid doing work. As the curves indicate, this control will not function where the working pressure is below the throttling pressure of the bleed off valve.

While there is the advantage of improved efficiency, this circuit does not provide the same accuracy of feed control as do the meter-in or meter-out circuits. This is because of pump slippage. For example, if the feed rate requires .5 gpm and a 5.0 gpm pump is in the circuit, the flow control valve is set to bleed off 4.5 gpm. If the work resistance causes a change in pump slippage to give a pump delivery of 4.85 gpm, then only .35 gpm will be going to the work cylinder. Using a pump having considerable variation in slippage makes the circuit impractical for accurate feed.



In Coming Issues . . .

. . . we will publish a series of articles on Servo Fundamentals for the hydraulic and pneumatic engineer. Prepared by F. B. MacLaren of Servomechanisms, Inc., the first article will appear in the August issue.

The 50th Anniversary of Powered Flight series will include articles on the development and use of "O" rings on aircraft by an ADC staff member and the first detailed description of the 4000 psi hydraulic system on the Bristol Britannia. This is the first production aircraft to use a 4000 psi system.

We will resume the Phillips series on Fluid Lines in the September issue. The next several installments will be on hose design and construction.

Additional details on the National Conference on Industrial Hydraulics will appear in the August and September issues.

The announcement of the winners in the APPLIED HYDRAULICS Prize Paper Contest, which closed on June 1, will be made in the September issue. The First Prize winning paper will be published in the October issue.

Circle 84 on Reader Service Card

SKINNER

Solenoid Valves

for air & hydraulic cylinders
fluid shut-off
diaphragm operated
equipment
coolant control

M2 BRONZE BODY

"M" SERIES pilot-operated Skinner Valves have extremely fast action, and large capacity on air, inert gas and liquid applications. All internal metal parts are stainless steel or brass. Soft seals prevent leakage — operate in any position — rubber coated, nylon fabric diaphragm for long life — port size ½" or ⅜", orifice ⅜" — power consumption, 10 watts — continuous duty.

M2 is two-way, normally closed, 5 to 150 p.s.i., weight 3 lbs. M3 is three-way, normally closed, normally open, or directional flow, 20 to 150 p.s.i., weight 3¾ lbs.

M3

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THE SKINNER CHUCK COMPANY
105 Edgewood Avenue, New Britain, Connecticut

FOR FAST, ECONOMICAL

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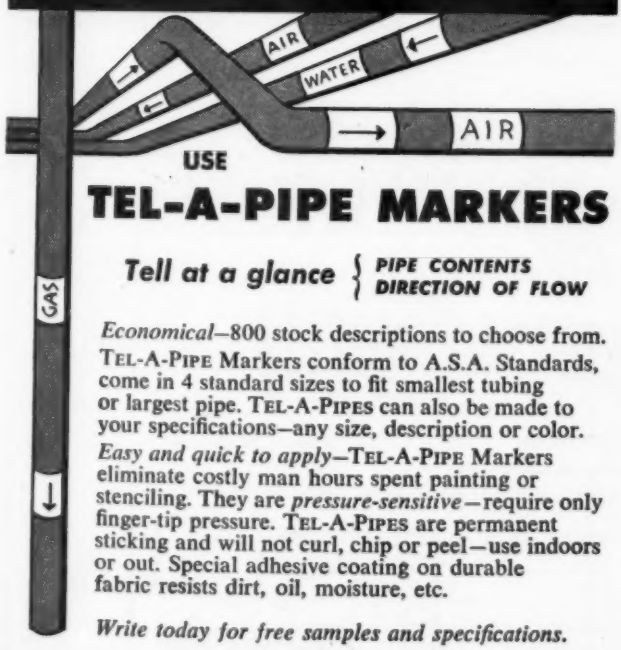

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Circle 11 on Reader Service Card

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LEAKPROOF—A choice of precision-made seals for highest pressures, temperatures, and steam or corrosive service.

SMALL, LIGHT, COMPACT—Standard models for ¼", ⅜", ½" and ⅝" O. D. tubing (A/N, flared, or Ermeto) or comparable size pipe threads. Angle or straight connections.

PRESSURE SAFE—The seal will not break or blow out suddenly. Built to 3000 psi working pressure standards, steel or aluminum. *Send for literature.*

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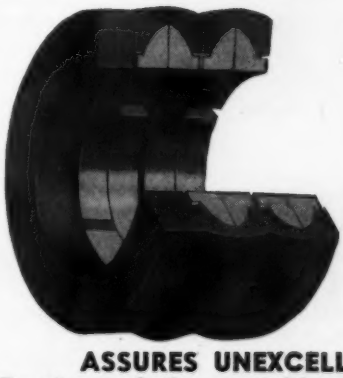
Prolongs the Life of Hydraulic Cylinders



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LONG

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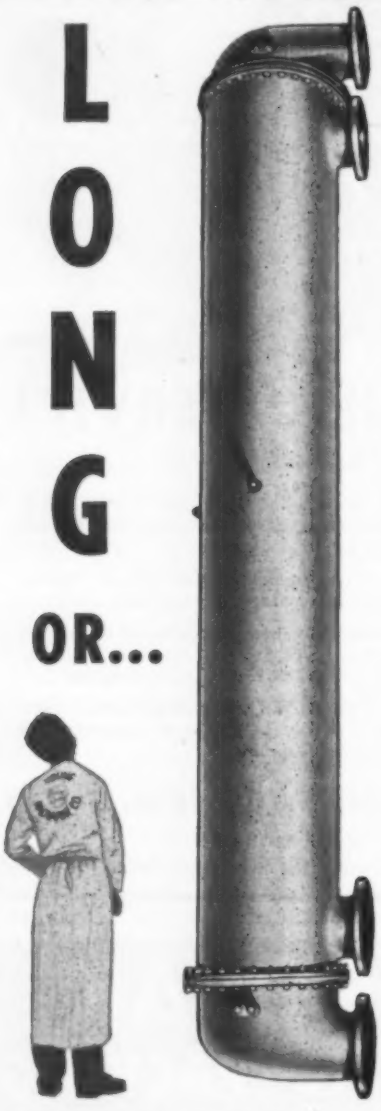
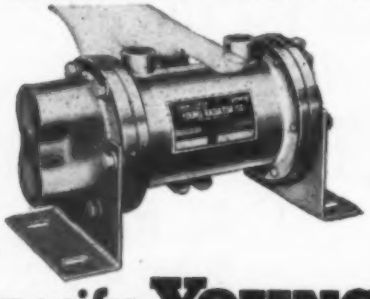


SHORT ONES...



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Heat Transfer Products for Automotive, Industrial, Gas or Diesel Engine Applications.

Heating, Cooling, Air Conditioning Products for Home and Industry.

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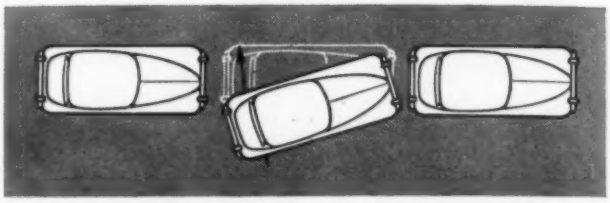
Gadget of the Month

. . . this oil powered device will slide your car into a tight space . . .



WITH THE REAR wheels raised by a hydraulic cylinder, a fluid motor driven fifth wheel slides the car into a tight parking space.

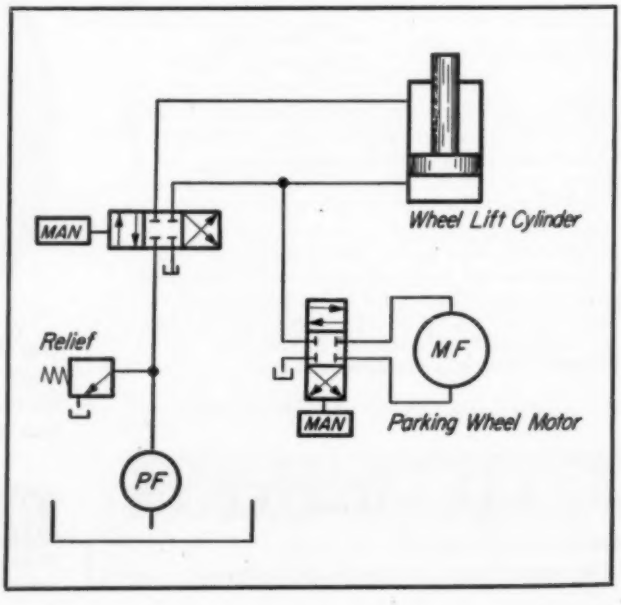
EVERY engineer hopes to hit on that "dream" invention which will become a household name. Some gadget for the kitchen or something for the family car has sure-fire marketability. With parking space at a premium in every city in the country, some of the "Rube Goldberg" designers are working out devices to park a 130 inch long car in a 130.062 inch space.

Here's a hydraulic design to do this tight parking job. Incidentally, this design has been patented by a Swiss engineer who must have his eye on the American market. With this device on your car, you have a hydraulic system which will raise the rear wheels and put into action a fifth wheel that is mounted at right angles to the longitudinal axis of the chassis. This fifth wheel, rotated by a fluid motor, slews the rear end of the car into the parking spot.

Uses Rotary and Spool Valve

The pump is driven from an engine take off and supplies pressure oil through the control valves to operate the rear wheel lift cylinder

COMPACT HYDRAULIC components can be installed on the car to raise the rear wheels and power a "parking" wheel.



and the fluid motor. In the Swiss design, a 4-way spool valve directs oil to the lift cylinder and a rotary 4-way supplies the fluid motor. A number of different arrangements of components is possible.

Last year, a company in California introduced a mechanically powered device to do this same job. Hydraulics offers a more compact package. You might also use the system to get those built-in hydraulic jacks that every automobile owner would like to have.

Denison Announces Scholarship Fund

William C. Denison, President of The Denison Engineering Company, announces the establishment of a new scholarship fund to foster interest on the part of Franklin County, Ohio (home country of the company) students in the study of hydraulic engineering. The fund to be known as The William C. Denison HydrOILic Scholarship Fund, will provide awards of $400 each year for one or more outstanding students to be selected by the Awards group.

The Awards Committee is made up of Glenn A. Rich, School Supervisor for the Ohio State Department of Education; Dr. Clyde E. Williams, Director of Battelle Memorial Institute; and William E. Taylor, Executive Secretary of the Columbus Industrial Association.

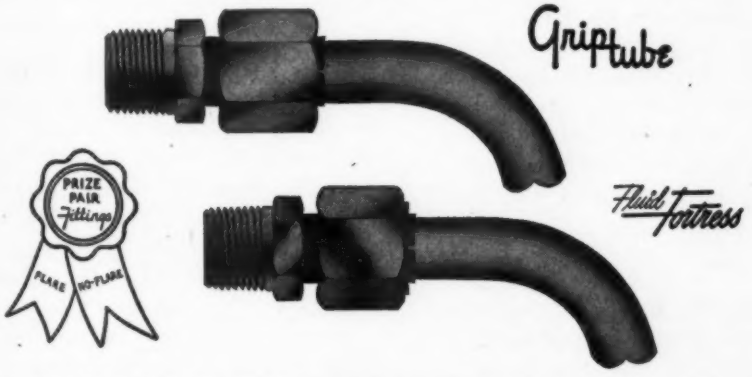
Two classes of scholarships have been established under the plan, one for high school students from Franklin County and the other for students with a parent in the employ of The Denison Engineering Company. The awards will be made on an annual basis for students pursuing a four-year course of studies in hydraulics or mechanical engineering in an approved school selected by the recipient.

Applicants must be under 25 years of age, be residents of Franklin County and maintain a scholastic average in the upper one-third of their high school graduating class. Such applicants shall not have received a similar award or scholarship.

PRIZE PAIR STANDARD (J.I.C.) TUBE FITTINGS

FEATURING THE ALLOY SPRING STEEL SLEEVE

. . . holds excessive pressures without leakage



FLODAR CORPORATION manufactures two lines of tube fittings.

PRIZE PAIR

(1) GRIPTUBE, a flare type, connector body AN dimensions with improved spring steel sleeve.

(2) FLUID FORTRESS, a no-flare type, eliminates flaring, threading, soldering, welding.

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FLODAR CORPORATION

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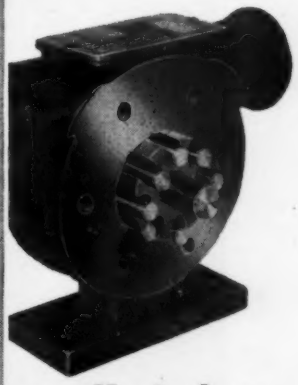
• Since 1926 • In the application, design and manufacture—pumps, separators, hydraulic accessories.

EQUIPMENT FOR FLUID POWER TRANSMISSION

Primary Oil Pumps • Vacuum Powered Transmission and Low Pressure Air Service • Air and Liquid Filters •

What's your problem?

- higher pumping speeds?
- tolerance of particle-laden liquids?
- peak suction for primary pumps?



the Kraissl-50 Roller Pump

is unmatched for dependable performance on every one of those counts.

Bulletin A-1330 has full data . . . write for it. The roller-rotor design easily handles particles that would jam more tightly-fitted mechanisms — reduces cavitation, allowing higher speed operation*—develops high suction characteristics.

*Roller mechanisms permit higher speeds with any oil than most displacement designs.

KRAISSL KRAISSL CO

305 Williams Ave., Hackensack

Post Scripts of Industry

News about people, manufacturers and sales organizations

Louis H. Schuette
Sundstrand Machine Tool Company

Stanley D. Peirce
Control Engineering Corporation

Donald D. Brock
Honan-Crane Corporation

Louis H. Schuette, vice president in charge of the **Hydraulic Division of Sundstrand Machine Tool Company,** was elected a director. Schuette started with the company in January 1941, in 1944 he was made chief engineer of the Hydraulic Division. In July 1947 he was appointed manager of sales and engineering, becoming general manager of the division in 1949. He was named vice president in charge of the division in June 1950. **J. E. McCann,** chief accounting officer, has been appointed assistant treasurer.

Control Engineering Corporation of Norwood, Mass., appointed **Stanley D. Peirce** as manager of the Government Contacts Division. Pierce was previously a senior electronic engineer with the Guided Missile Division of the Fairchild Airplane and Engine Company.

Donald D. Brock has joined the **Honan-Crane Corporation** as sales engineer for the Kansas City area. Brock was previously associated with the Sinclair Refining Company in Kansas City.

J. J. Mudd, Midwest regional manager of **The Bellows Co.,** Akron, Ohio, announced the appointment of two field engineers to service territories with the following headquarters: **W. W. Smith,** The Bellows Co., 3030 Euclid Ave., Cleveland, Ohio; and **David J. Trepanier,** The Bellows Co., 220 W. Market Street, Akron, Ohio.

A new factory will be opened shortly at Warren, Illinois, about 25 miles north of Freeport, to expand the production of the **Micro Division of Minneapolis-Honeywell Regulator Company.** The new plant, a 10,000 square foot building obtained under a lease arrangement, will become the division's fourth manufacturing operation. Approximately 150 persons will be employed initially in the new operation.

The **M & N Hydraulic Press Company** recently moved into its newly built plant located at 780 Route #3, Clifton, New Jersey. The firm was formerly located at 287-293 Allwood Road, Clifton, and was known for years as the M & N Machine Tool Works.

Victor W. Farris, president of **Farris Engineering Corporation,** of Palisades Park, N. J., announced the acquisition of the **Pickering Governor Company,** including all patent and inventory. With this change of ownership the firm becomes a Farris affiliate and will be known as the **Farris Pickering Governor Company.**

The Hydraulic Press Mfg. Co. of Mount Gilead, Ohio announced a new manufacturing center abroad, which will produce the full line of HPM equipment for distribution in Western Europe and other territories. Complete sales, service and manufacturing facilities will be coordinated through Hydraulische Pers Maatschapij Nederland, N. V., a wholly owned company subsidiary with headquarters at 558 Keizersgracht in Amsterdam. Manufacturing facilities have been established with Gebr. Stork & Co., N. V., Hengelo, Netherlands.

Hoke, Inc. of Englewood, N. J., has appointed **Earl B. Hitchcock** as general sales manager. Although his work in the past few years has been in sales, he spent much of his working life in the engineering field. For several years he was employed by General Electric as a test engineer, but switched to sales engineering. Later at Potter Instrument Company, Hitchcock continued his sales engineering experience as assistant sales manager.

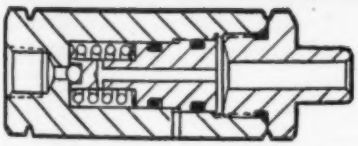
The Rucker Company, Oakland, California announced the following appointments: **Wayne Harmon** to assistant chief engineer. Harmon, long-time engineering consultant, has had 26 years experience designing, building and operating most of it with process industries on the West Coast and Alaska. **C. J. Niven** to manage Rucker branch office in Seattle. Niven has been with the company five years as a field engineer in the Los Angeles and Oakland offices.

Oliver Iron and Steel Corporation announces the establishment of a new **Berry Division** Midwestern sales office to service Northern Illinois, Northern Indiana, Wisconsin, Minnesota and Iowa. **Charles E. Finn** was appointed as sales manager. The office is located at 122 South Michigan Avenue, Chicago 3, Illinois.

Greer Hydraulics, Inc., of Brooklyn, N. Y., announced the appointment of William B. Killough as director of personnel, a new post within the company. Prior to coming with Greer Hydraulics, he was with the U. S. Air Force at the Marietta, Georgia plant of the Lockheed Aircraft Corporation.

The Cleco Division of the Reed Roller Bit Company, Houston, Texas, has announced the appointment as distributors of: R. C. Bowers Supply Co., Inc., Montpelier, Vermont; Choate Equipment Co., Inc., Cedar Rapids, Iowa; Lewis Hardware Company, Borger, Texas; La Grand Industrial Supply Company, Portland, Oregon; The Sidney B. Roby Company, Rochester, New York; and Fehrs Tractor and Equipment Co., Inc., Omaha, Nebraska.

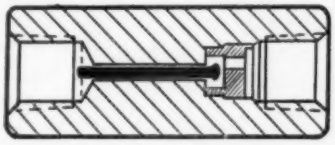
REPUBLIC
VALVES
INDUSTRIAL • CHEMICAL • AIRCRAFT



REPUBLIC GAGE PROTECTOR

PROTECT your expensive gages from severe pressure fluctuations and shock with Republic gage protectors and snubbers. Designed for a wide range of settings and service conditions. Standard units are brass, with pipe thread connections as shown. Other materials and connections are available on special order. Gage protectors fit standard gage connections, 15 to 5,000 psi.

REPUBLIC PRESSURE GAGE SNUBBER



Write for complete catalog and nearest distributor.

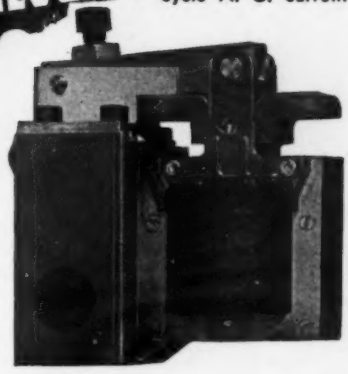
RM REPUBLIC MANUFACTURING CO.
1930 WEST 77TH STREET • CLEVELAND 2, OHIO

NEW HIGH PRESSURE SOLENOID VALVES

Now available in 110—220 volts 60 cycle A. C. current

Features

- Rugged compact construction.
- 3000 P.S.I. operating pressure
- Continuous duty
- Poppet design eliminates leakage
- May be mounted in any position
- Impregnated coils resist moisture and condensation



Waterman High Pressure Solenoid Valves are inexpensive, compact units designed for continuous duty in hydraulic systems where pressures are as high as 3000 P.S.I. Poppet type construction gives positive sealing against internal leakage. Impregnated oil resistant coils make these valves suitable for mounting in oil reservoirs. In many cases this feature eliminates costly piping and makes possible the construction of smaller, more compact hydraulic power units. Available in ⅜" and ¾" pipe size.

Write for Illustrated Circular A

WATERMAN ENGINEERING Company
725 CUSTER AVENUE
EVANSTON, ILLINOIS

Post Scripts of Industry

Continued

National Motor Bearing Co., Inc., has expanded its O-ring manufacturing facilities and has included O-rings among the sealing items distributed through its nation-wide sales staff and jobber organization.

J. A. Wilson Jr. has been appointed assistant chief engineer of the **C. A. Norgren Co.** in Englewood. Wilson has been in Norgren engineering since 1950, serving as chief draftsman and supervisor of design and drafting.

The Industrial Products Division of the **Westinghouse Air Brake Company** announces the appointment of **E. M. Cook** as sales engineer in the Cleveland district with headquarters at 1116 Midland Building, Cleveland 16, Ohio.

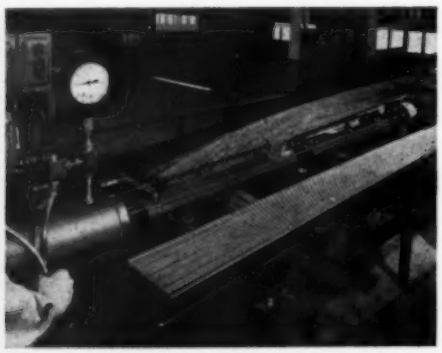
Arthur S. Iberall
Aro Equipment Corporation

The appointment of **Arthur S. Iberall** to direct the newly formed research and development department in its Aircraft Division in Cleveland, Ohio, was announced by the **Aro Equipment Corp.** In addition to his executive duties Iberall will serve as a consultant to Aro customers needing technical guidance.

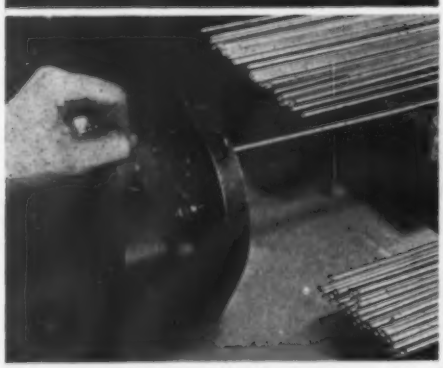
Peter A. Frasse and Co., Inc., steel distributor, who for many years has maintained a sales office in Hartford serviced by its New York warehouse, is now constructing a new office and warehouse building on a tract of land located on Locust Street in Hartford, Conn. Completely modern in design and serviced by the latest in materials handling equipment, the new building will enable the firm to service the needs of steel users in the Connecticut and New England area.

Pioneer Pump Division, Detroit Harvester Company, appointed the following representatives to handle sales and engineering of their complete line of Pioneer and Rollway centrifugal and positive displacement pumps. Virginian Electric, Inc., of Charleston, West Virginia, will be the exclusive representative in West Virginia and the adjoining counties of Virginia, Ohio and Kentucky. Shop

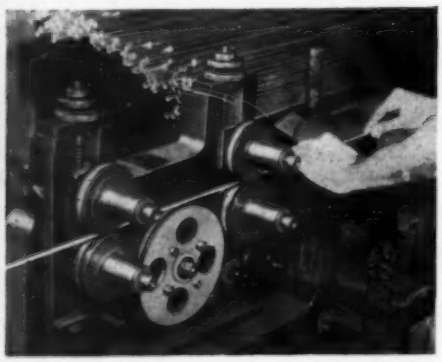
If you can't place your hydraulic tubing in all 3 of these pictures it isn't SUPERIOR hydraulic tubing



1. HYDROSTATIC TEST—Every single length of Superior hydraulic quality tubing is 100% hydrostatic-tested. This is only possible, economically, because of Superior's invention of a super-speed clamp.



2. FLAREABILITY TEST—Each order of Superior hydraulic tubing is sampled for flareability. Superior's low-carbon Hydraulic Tubing (0.12% maximum) greatly increases ease of flaring and bending.



3. MARKING—Every length of Superior hydraulic tubing is marked with indelible ink so that you cannot mistake that it is hydraulic quality and its source is Superior.

Superior low-carbon Hydraulic tubing is specially made to attain a non-aging tubing with low ultimate tensile strength and high elongation for good ductility.

Sizes available from all Superior distributors—.125" to 1.125" O.D. Temper #1, dead-soft annealed, Bulletin 38 will bring you complete information on analyses, sizes, lengths, properties, and recommended working pressures. Use the coupon.

Superior
THE BIG NAME IN SMALL TUBING

Superior Tube Company
2030 Germantown Ave., Norristown, Pa.

Please send me at once your newest folder on Superior Hydraulic Tubing.

Name_____
Title_____
Firm_____
Address_____
City_____ Zone____ State_____

Supply Company, 2412 Second Avenue, Birmingham Alabama, will cover the Alabama, Georgia and Tennessee territory, and W. H. Erskine Company of Minneapolis will be the representative in Minnesota.

Sam E. Gewin has been appointed district manager of the St. Louis office of **The Bristol Company**, Waterbury, Connecticut. He was previously associated with the **U. S. Industrial Chemical Company** for 3 years prior to joining The Bristol sales organization as sales engineer in 1937. For the last five years he has been resident sales engineer in the Buffalo area.

Harold A. Price
The Rucker Company

Clarence J. Woodard
The Rucker Company

Harold A. Price, former chief engineer, has been promoted to the newly created position of chief engineer and director of sales, and **Clarence J. Woodard** has been appointed West Coast sales manager for **The Rucker Company**, Oakland, California.

Donald B. Guy, manager, Bellows Pneumatic Devices of Canada, Ltd., a subsidiary of **The Bellows Co.**, Akron, Ohio, announced the appointment of four field engineers to service the following territories: **Earl G. Berwick**, Toronto; **Manning Otis**, Toronto; **Lorne H. Hay**, Toronto; and **Henry E. Hall**, Montreal. Headquarters of the company are at 4972 Dundas Street West, Toronto 18, Ontario and 1000 Cremazie Street, Montreal, Que.

Members of the board of directors of **Pacific Airmotive Corporation** elected **Edward H. Farmer**, former Lockheed works manager, as vice president-manufacturing. Farmer joined the Burbank branch of Lockheed Aircraft Corporation in 1941. Executive posts held by Farmer at Lockheed included Fabrication Division superintendent, assistant chief tool engineer, plant engineer, manufacturing control division manager as well as works manager.

Pace-Turpin and Company, 726 South Third West, Salt Lake City 4, Utah, has been appointed distributor for tube fittings manufactured by **The Parker Appliance Company**, Cleveland.

TRADE MARK
"FULFLO"
REG U.S. PAT. OFF.
OIL BY-PASS
RELIEF VALVES
NEED NO MAINTENANCE
Precision-engineered to maintain predetermined pressures on
• ram presses
• machine tool hydraulic mechanisms
• diesel and oil-burning equipment
Trouble-free because built with fewest parts. Engineered for dependable, quiet, constant performance.
NON-CHATTERING . . . no pounding noise.
TODAY . . . write for your personal, professional edition (use letterhead, please) of FULFLO MECHANICAL DATA BOOK
BRASS OR CAST IRON
For pressures from 0 to 500 lbs.
Pipe Sizes ¼" to 2"
Standard or Flange Types
FULFLO
FULFLO
THE FULFLO SPECIALTIES CO. Inc.
BLANCHESTER, OHIO

Hydraulic and Pneumatic Equipment Shown at British Industries Fair

New Products aimed for export

THE British Industries Fair, Britain's largest Trade Fair, was held at London and Birmingham from April 27 to May 8. As in the past, the Heavy Engineering Section, at which most of the hydraulic and pneumatic equipment was shown, was exhibited at Castle Bromwich exhibition hall, Birmingham. The effect of the Coronation was reflected in the heavy attendance which was considerably larger than last year.

The Keelavite Company of Coventry exhibited their "Flow Divider" which synchronized two ram cylinders. Two hydraulic cylinders, one with a heavy load and the other with a light load or no-load, are very difficult to move in unison. The "Flow Divider" was designed to do this. One piston was loaded by four powerful springs, which opposed travel in one direction and aided travel in the other. The total maximum load of the battery of springs was one ton. Alongside the spring loaded cylinder was a cylinder operating under zero load. When either "extend" or "contract" selection was operated both pistons moved exactly in unison. The details of the mechanism were not divulged.

the right speed always to FIT THE JOB!
LOVEJOY
SELECT-O-SPEED
Variable Speed Transmissions
A Select-O-Speed Transmission is used here to drive and control the speed of a pulley and flexible shaft connected to a vibrator that checks vibration of vehicular components at changing speeds.
Lovejoy's accurate, easily installed Select-O-Speed Transmission gives you complete and instant speed control on all types of machinery—new or old. Even while the machine is running you can adjust to an almost infinite number of speed variations.
Adjustments for testing . . . operator ability . . . variously sized parts or stock . . . material differences . . . any other operational variables . . . can be accomplished without loss of time or labor.
Lovejoy Select-O-Speed Transmissions provide better, more efficient production control to help you improve the quality of your products.
Speed ratios to 10 to 1. Sizes to 5 hp. Hand lever or wheel control. Operate with standard V-Belt drives. Fully enclosed. Send now for illustrated catalog giving complete information.
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Mfrs. of flexible couplings, universal joints, variable speed pulleys and variable speed transmissions.
LOVEJOY

New Power-Pack

Finney Presses, Ltd., who are the British Licencees of Greer hydraulic equipment, exhibited a power-pack which it proposed to offer in the North American market in the near future. This pump-motor-tank assembly provides a low pressure-high delivery gear pump (over 10 gpm at 150 psi) for fast approach, backed up by a high pressure pump (3 gpm at up to 6000 psi).

One company exhibited a new hydraulic die cushion, which it claims is cheaper in first cost, installation and maintenance than pneumatic die cushions. No air compressors or receivers are required and leakage is automatically returned to tank.

One of the new pieces of handling equipment was a hydraulic loading table for raising heavy loads such as dies to platen level for inserting in presses or similar work-positioning jobs. This machine was fitted to an all steel multi-ram hydraulic press of 60 tons and upwards capacity. This type of construction is said to be cheaper and quicker to build than the cast iron type.

For aircraft maintenance a new mobile platform, operated by hydraulic power, was shown. The platform is capable of carrying four men to any height required for reaching the highest portions of an aircraft for servicing and inspection.

Numerous hydraulic seals and packings were on display, including many manufactured from silicone rubbers. The Dowty Seals Company, exhibiting for the first time at a B.I.F., included a wide range of

glands and moulded synthetic rubber products. These included their Bonded Seals — known in the United States as Dyna-Seals — and Struds, which are countersunk screws with a synthetic rubber collar bonded at the neck of the countersunk cone to make them self-sealing. These Struds are widely used in the De Havilland Comet jet aircraft for construction of the fuel tanks.

It is apparent that British engineers are developing new and interesting products, and, of particular importance in the export field, strenuous efforts are being made to quote and keep to competitive delivery dates and prices.

John A. Lankester

Westinghouse Air Brake Accelerates Expansion Program

Westinghouse Air Brake Company has purchased the earth-moving and related business of R. G. LeTourneau, Inc., including all fixed assets and machinery at Peoria, Illinois, Toccoa, Georgia, and its interest in the Australian subsidiary. The new business will be operated as the LeTourneau-Westinghouse Company, a subsidiary of Westinghouse Air Brake.

THE MARKET PLACE

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seeking to expand local sales operations, desires additional items. Will consider only HYDRAULIC and PNEUMATIC equipment, or components. Can act as a stocking distributor or exclusive agent in the State of Michigan. Must deal directly with principal. Hydraulic Accessories Co. 24301 Hoover Road, Van Dyke, (Detroit) Michigan.

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Progressive Cleveland, Ohio, manufacturer has two excellent permanent positions for Project Engineers with design experience in hydraulic components. One man desired with experience in hydraulic pump design and one man experienced in hydraulic valve design for machine tool applications. Salary commensurate with ability and experience; plus many company paid benefits. Write giving brief resume of experience and qualifications to: Box 7253, APPLIED HYDRAULICS.

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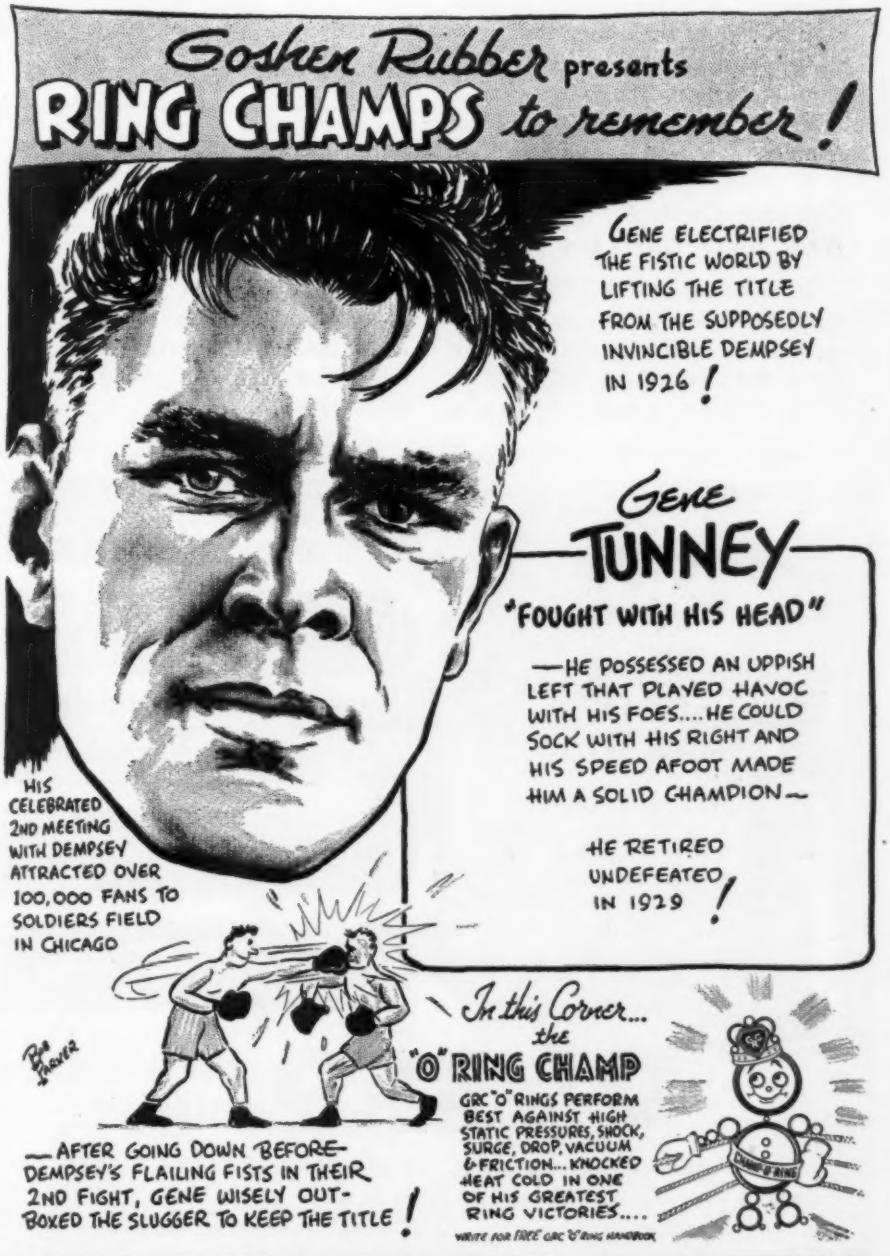
A leading manufacturer of hydraulic equipment desires an outstanding young man to assist in an expanded research and development program. Sound educational background with some practical experience in high pressures and pump design is required. The candidate should be fully capable of taking charge of this program within a reasonable time after employment. This project offers a splendid opportunity for professional development together with attractive earnings and advancement. Please send complete resume, including age and earnings record to arrange for personal interview. All contacts will be handled in strictest confidence. Address: Box 7353 APPLIED HYDRAULICS.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Circle 39 on Reader Service Card

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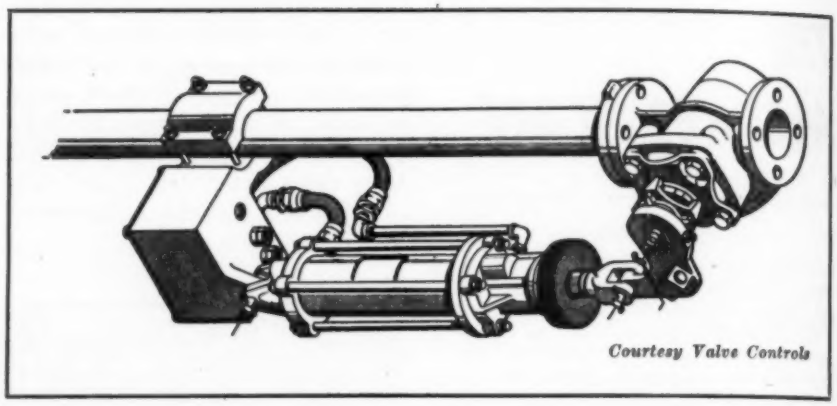

Courtesy Valve Controls

Cylinder Control With Timer Operated Valve

To make this check of the crude oil, a three way plug valve is used to divert the flow into a test tank where the analysis is made. Use of an air cylinder, actuated by a solenoid valve, to position the large plug valve in the oil line, now makes this operation automatic.

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- Interchangeable Pistons
- Interchangeable Pistons 3/8-1/2-3/4 inch

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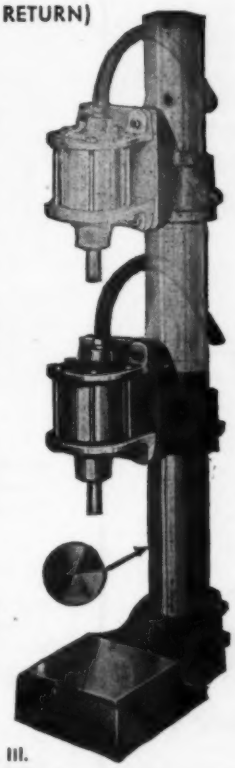

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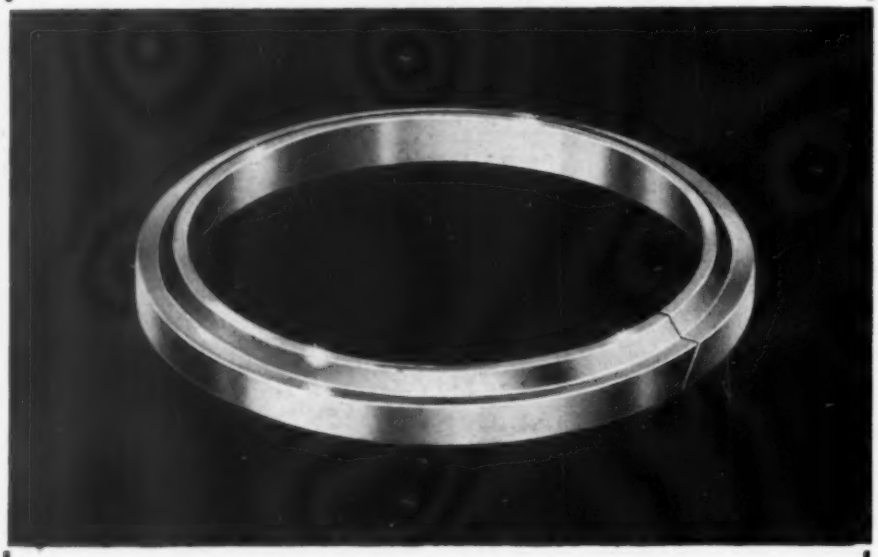

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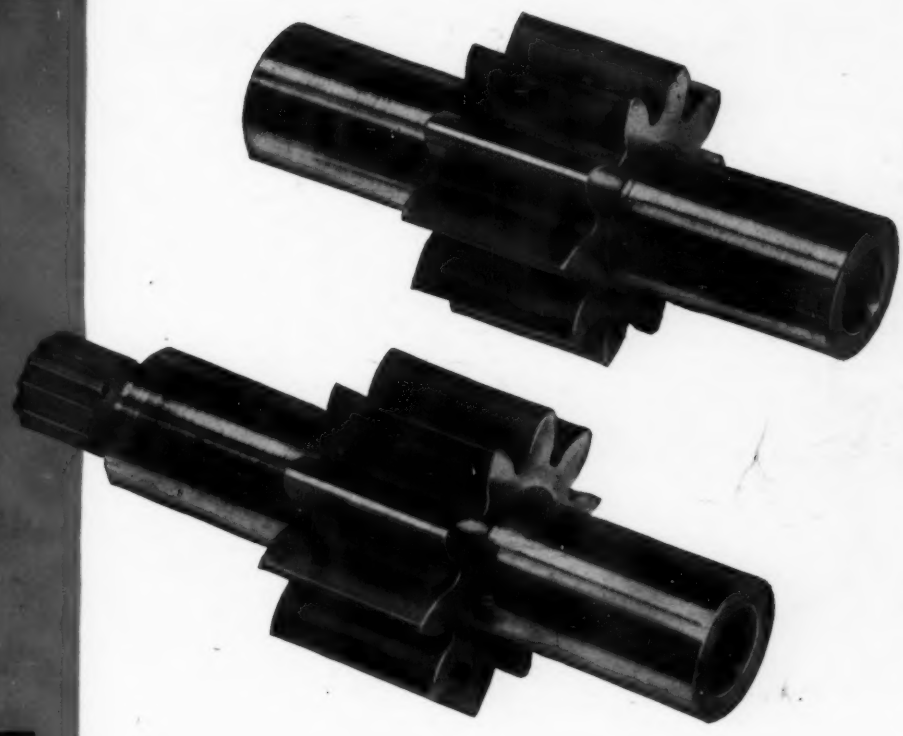

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